Heating and Ventilating

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FORMERLY THE HEATING AND VENTILATING MAGAZINE

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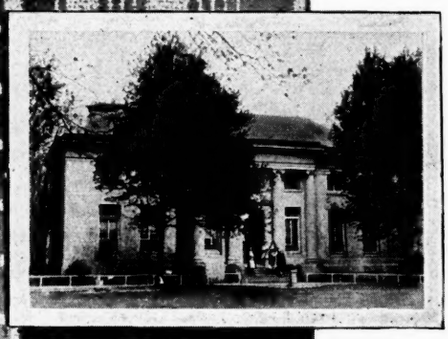

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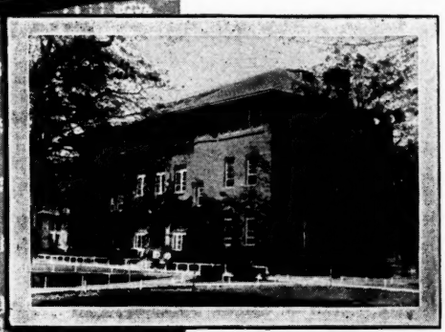

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EDITORIALS

Instruments for Heating Plants

A GREAT variety of reliable and trustworthy operating, control, and recording instruments are now available on the market. While they have been very widely adopted in utility and in industrial plants, they have been but relatively little used in building heating plants of comparable characteristics. The reasons usually given for this condition of affairs is that their use in these plants is not justified because of the low grade of operator and because of the increase in first cost of the plant.

If these reasons are really valid objections then probably the omission of instruments is justified.

The argument that instruments should be omitted because of a lack of skilled operators may apply to the use of the indicating type of instrument. If the operator is either unwilling or unable to use the indications of the instruments as a guide in the operation, there is indeed little justification for their installation.

Certainly this reasoning can not be construed to apply to control type instruments, especially those of an automatic nature. The lower the grade of operator provided the more justification there is for installing automatic operating controls as the details of operation are thus taken out of the hands of the operator and entrusted to the instruments. Instruments of this nature are available whereby practically any plant can be almost wholly instrument-operated, and this can be accomplished with greater reliability in service than with even a high grade operator.

Often there is the possibility that by providing operating control instruments, the building personnel may be reduced to such a point that the added investment is well worthwhile. Where no real reduction can be made, the time of the operator is at least made available for other duties which time should be, but often is not, credited to the use of instruments. The item of automatic instruments is worth more consideration in the design of heating plants than it usually receives.

Recording instruments are often of such value as keys to misoperation or trouble, as well as for accounting purposes, that they are really in a class by themselves and should be considered as necessary adjuncts if economy and reasonably accurate accounting are of importance. They may also be used as a spur to a lagging operator since operators are human and are much more likely to attempt to secure good results if they know that a permanent record is being kept. Recording instruments are as desirable in a heating plant of any considerable size as is a cash register in a retail store.

●

Studying Market Wastes

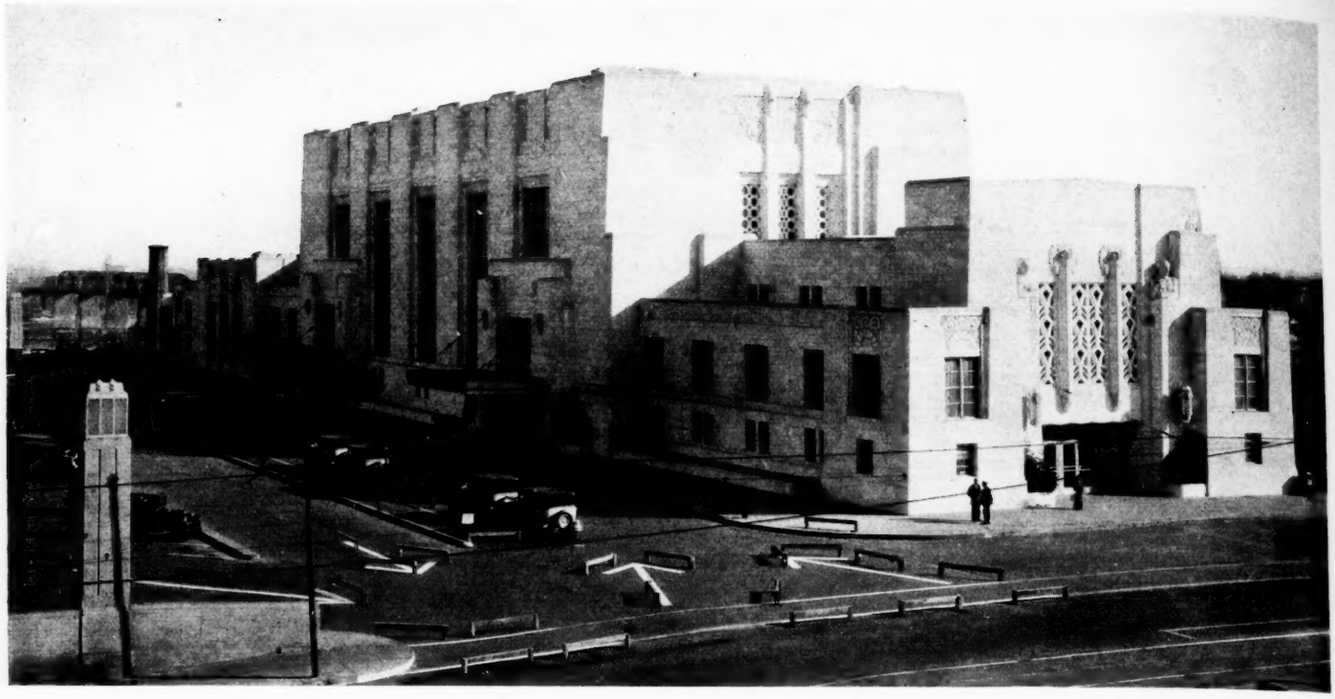
ROGER BABSON, in a recent statement to the press, expressed the opinion that the keynote to future prosperity lies in improvement in distribution methods. He classified the causes of distribution waste into those for which the producer or manufacturer is responsible and those which may be laid at the door of the merchant. In the first class are insufficient market study, the production of a multiplicity of sizes and styles not needed by the consumer, and failure to keep abreast of changing consumer trends.

Certain of the heating and ventilating manufacturers have taken notable steps both in studying some of the items and in putting the findings into use.

Manufacturers of pipe and fittings have gone far in standardizing their products by cooperating with the American Standards Association. The oil burner manufacturers, through their association, have done a highly creditable piece of work together with the Department of Commerce in defining fuel oil classifications.

More recently the Steel Heating Boiler Institute, working through the Division of Simplified Practice of the Bureau of Standards, completed a survey which showed that 84% of shipments of steel heating boilers were in 20% of the total variety of sizes. One noteworthy fact brought out by the survey is that it was found that there were no shipments in two types of boilers available in over 90 ratings.

It cannot, therefore, be said that the heating and ventilating industry has been markedly backward in studying its position. On the other hand, in spite of these instances, there are undoubtedly other places where there is still needless and unprofitable duplication of products and of efforts. The present seems like an especially good time to undertake studies to determine the facts. Enough organizations and enough machinery are in existence to pursue such studies to advantage. What seems to be most needed is to have the possibilities of saving driven home, followed by active steps to actually get the necessary data. Both of these efforts lie in the field of trade associations which must be looked to, to take the initial steps or to continue their activities.



Heating and Ventilating Omaha's Union Railway Station

By MARTIN T. HOOPER†

ENGRAVED over the west entrance on the north side of the new Omaha Union Station are the words "Dedicated by the railways of Omaha to the service, comfort and convenience of the people." This phrase exemplifies the central theme that actuated the Union Pacific Railroad, the builders of Omaha's new passenger terminal, in planning the facilities for easy entrance to and exit from the 90 regular trains arriving and departing each day.

It is needless to say that the mechanical equipment layout as designed and installed plays quite a part in the execution of the design of the terminal.

Departing passengers who arrive on the plaza or north side of the station, step from their car or taxi under the shelter of two wide overhanging marquises. From these the passenger enters a vestibule and emerges into the main waiting room of the station, a room 72 ft. x 160 ft. x 60 ft. high.

On turning to either right or left on the north side of the waiting room the passenger finds the ticket office. Close at hand the passenger may find in the station the restaurant, baggage room and check stands, news stand, telephone or telegraph, barber shop and rest rooms.

The street car passenger arrives at the Tenth Street entrance of the depot and enters through a vestibule into the Great Hall of the station which is bordered on either side by various of the station facilities, including offices of the station officials, hospital, travelers' aid, barber shop, rest rooms, telephone and telegraph stands.

Directly opposite the ticket offices are the controlled exits to the concourse vestibule which extends the entire east and west length of the main waiting room. This vestibule opens through double-acting doors to the concourse proper. Enclosed stairways leading from either side of the concourse descend to the tracks.

The incoming passenger reverses this movement. Ascending the stairways from the train platforms and arriving in the concourse vestibule he finds three broad exits to the waiting room.

The Layout

The design of the heating equipment for this structure is for a modified split system and does not include air conditioning apparatus.

As designed, it is intended to supply clean, tempered air of the proper humidity and temperature to certain parts of the building, including the main waiting room and, with the exception of the dining room and kitchen, all space at the street or first floor level, establishing as nearly as possible with the apparatus as specified the following conditions:

	Outside Dry Bulb Temperature	*Inside Dry Bulb Temperature*	*Inside Wet Bulb Temperature*	*Relative Humidity*
Winter	10°	70°	57°	45%
Summer	95°	85°	—	—

†Mechanical Engineer, Office of Gilbert Stanley Underwood, Architect, Los Angeles.

Omaha's new three and a half million dollar Union Station, serving seven of the railroads which make Omaha the fourth greatest railroad center in the country, constitutes a celebrated example of the type of architecture embodied in its design. Architecturally it is the only one of its kind, excepting only the station in Helsingfors, Finland, and a few in Sweden and Germany. Some idea of the size of the project can be gathered from the quantities of materials used for the heating and ventilating installation . . . galvanized duct work amounted to approximately one hundred and thirty tons, while the piping for steam and condensate weighed eighteen tons.

Ventilation

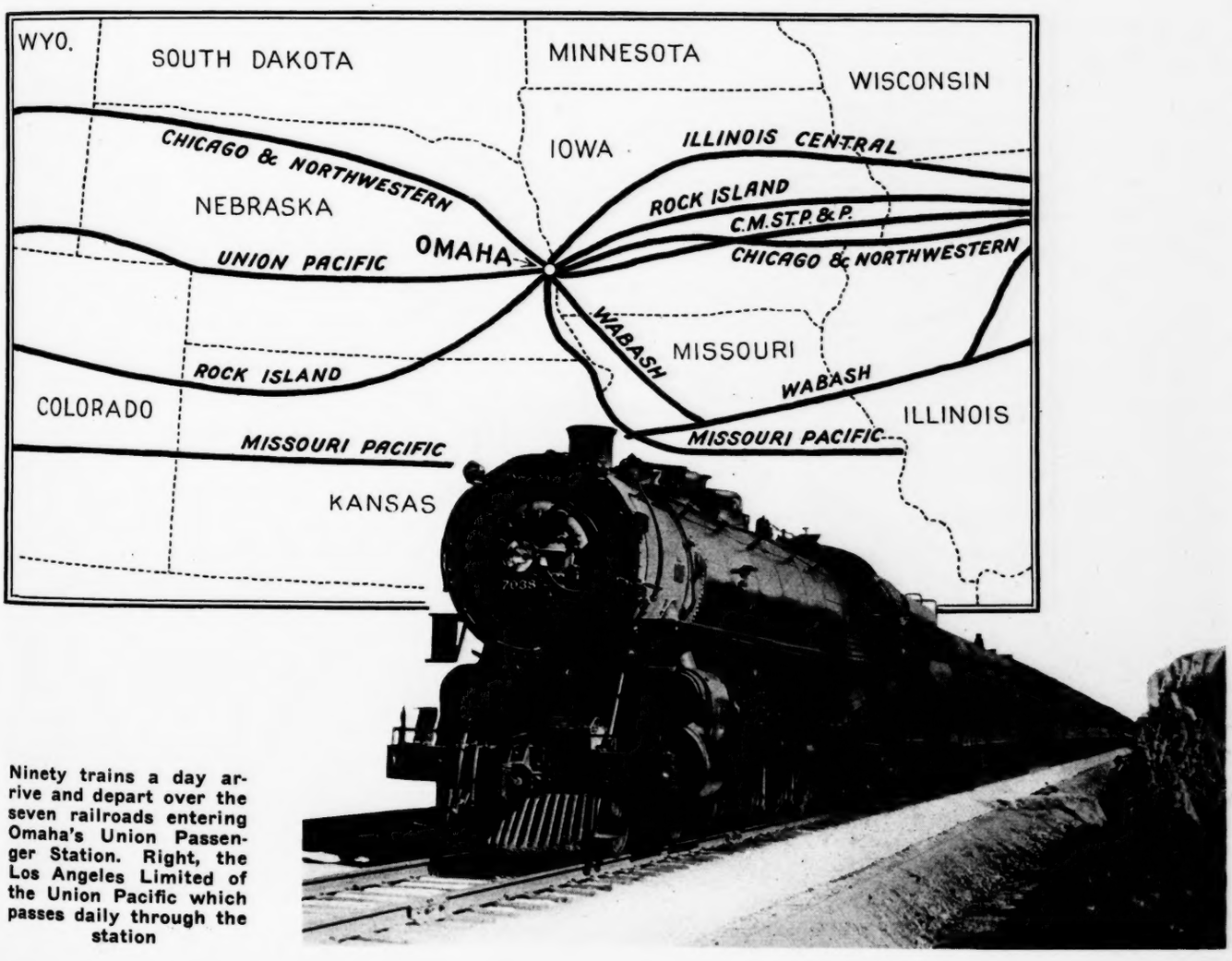
The main waiting room, containing approximately 1,000,000 cu. ft. with an estimated seating capacity of 250, is the largest single space or room to be ventilated.

Based on a 10 min. air change (for summer) there is an air supply of approximately 30 c.f.m. per person in the main waiting room. The air supply is introduced through ends of the seats and top of high backs of the seats with recirculating or exhaust grilles in outside walls near floor line. In the interest of economy the layout as designed provides for at least 75% of the air supplied (during heating months) to be recirculated. Vitiated air from the main waiting room is exhausted (during summer months) through grilles in ceiling.

The fan system which supplies fresh air to the waiting room is located in the fan and heater room below the first floor and is rated at 60,000 c.f.m. Exhaust fans and the duct system used in connection with this are located in the roof space and each have a capacity of 29,000 c.f.m.

The three street entrance vestibules and the three entrances from concourse are provided with unit heaters and are so located as to protect the waiting room against cold air entering from these openings.

The second largest room to be ventilated is the dining and lunch room containing 121,000 cu. ft. and has an exhaust system giving an 8 min. air change. Fresh air is supplied through pivoted opening in windows.



Ninety trains a day arrive and depart over the seven railroads entering Omaha's Union Passenger Station. Right, the Los Angeles Limited of the Union Pacific which passes daily through the station

Exhaust is through grilles located in ceiling and connected through system of ducts to the two exhaust fans, each rated 7,500 c.f.m. The fan rooms are located in the space over the dining room. Due to the comparatively high ceilings of the dining and lunch room, the design included four unit heaters in addition to the direct steam radiation. The unit heaters are located in outside walls, each with rated capacity of 2,200 c.f.m.

The kitchen contains 50,000 cu. ft. and has a 3 min. air change. The air is introduced through pivoted openings in the windows. The exhaust grilles and duct system are located in the ceiling of the kitchen. The kitchen exhaust fan is in the fan room located in a fireproof space over the kitchen. Duct work at the point entering fan room is equipped with a fused-link fire damper. The motor for the kitchen exhaust fan is provided with a heavy sheet metal enclosure with louvers venting to the outside.

A 6 min. air change for the toilet and wash room, smoking rooms and sink closets is provided by an exhaust fan and duct system, the fan being located on the third floor level and the ducts suspended below the first floor. Air is introduced through grille work in the door panels. Exhaust grilles are in the side walls.

Telephone booths are provided with 4 min. air change. Exhaust grilles are located in the ceilings of the booths. The fan and duct system is entirely an independent ventilating unit.

There are 11 supply fans handling 88,750 c.f.m. and 8 fans handling 84,000 c.f.m., making a grand total of 172,000 c.f.m. of air being moved when all of the fans are operating at rating. The motor installation for the fan drives totals 102 hp., one of the motors being variable speed and 18 being constant speed. Remote controls for all fan motors except dining room and kitchen are located adjoining the station master's office. Remote controls for dining room and kitchen fan motors are located in the dining room manager's office.

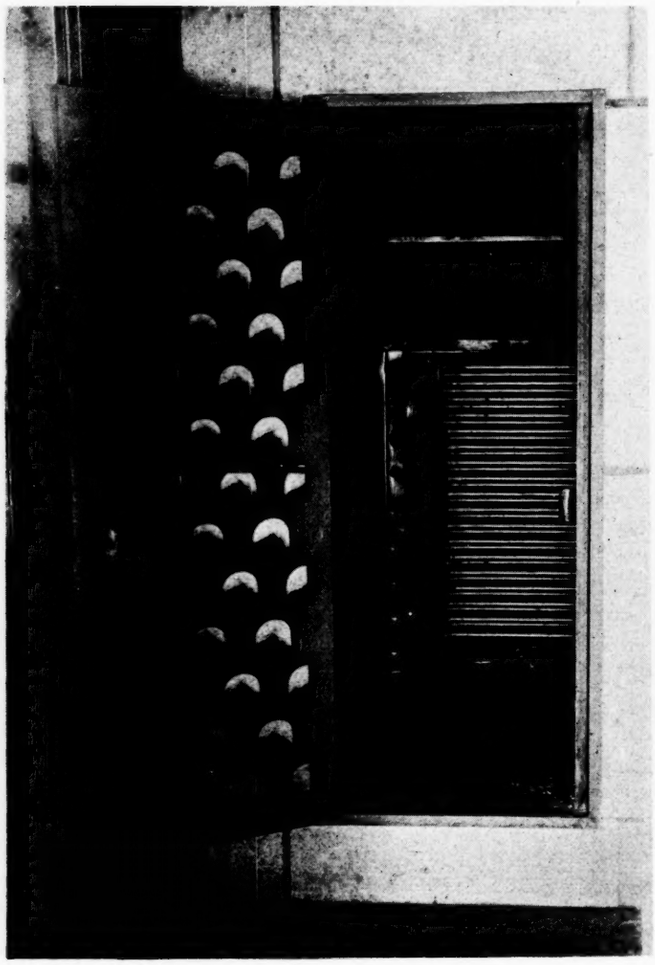
Fans are all erected on anti-vibration platforms. This is essential for noiseless operation, especially for the fans located over the main waiting room and dining room.

Air filters and humidity regulation are installed in connection with the supply fan for the main waiting room, in order that during periods of recirculating the waiting room may be kept as free from dirt and dust as possible.

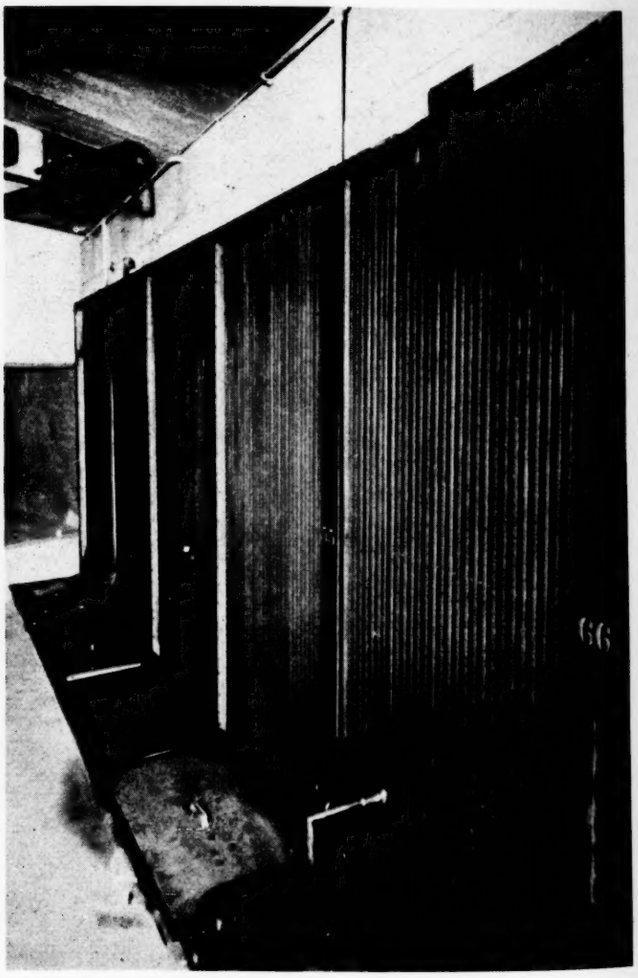
Heater coils of copper with extended surface, totaling 3,800 lin. ft. with approximately 320 sq. ft. of face area, make up the heating surface for the hot blast and unit heaters.

Galvanized steel duct work required in connection with the ventilation of the building amounts to approximately 130 tons.

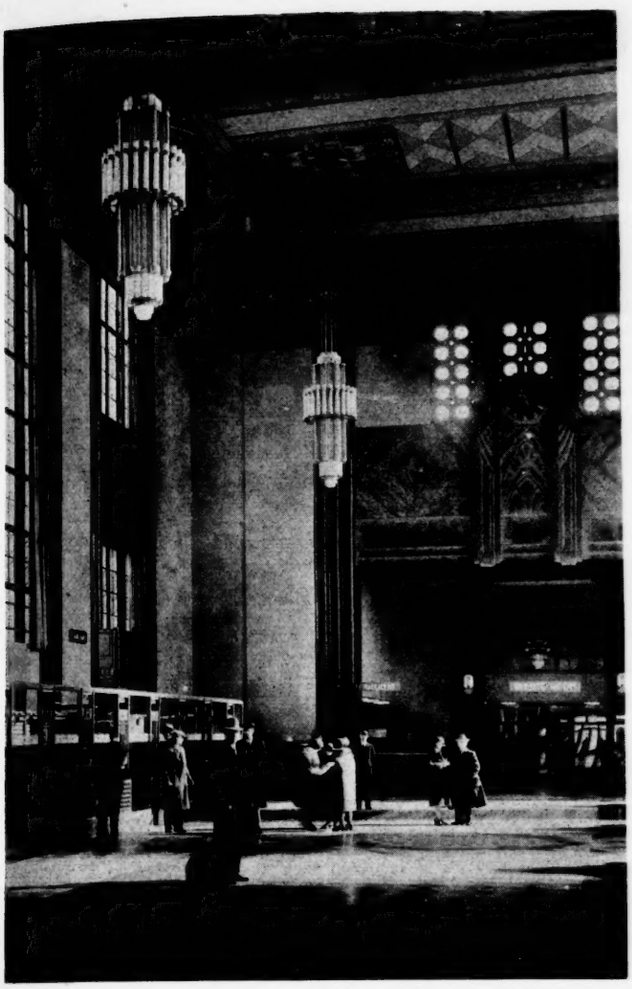
Gravity ventilators venting the roof spaces and the fan discharges through the roof are of the rectangular



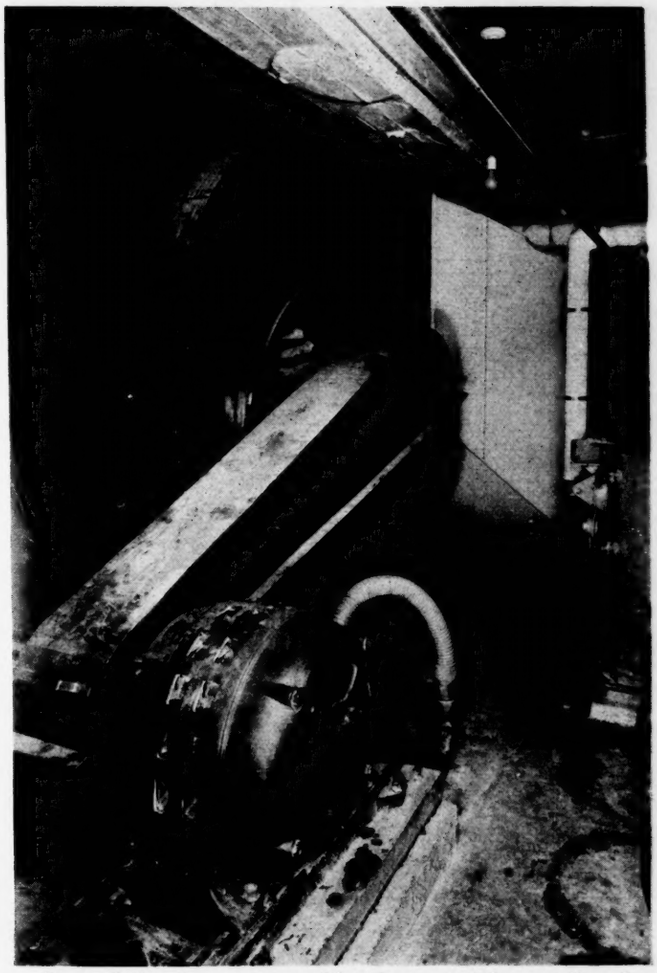
Heaters in the entrance to the station



Air cleaners in the Omaha station



Main waiting room of the Union Station



Part of the fan system which has a total capacity of 60,000 c.f.m.

low head type. Due to the objectionable visibility, the ordinary round type ventilators were not used. All ventilators were equipped with blade dampers.

Remote control for damper air motors is provided without exception throughout the system of ventilation. Dampers in each of gravity roof ventilators heads are included under this system of control. The valve panel board is located in boiler room.

Steam Service and Distribution

The owners supply the steam service required in connection with heating and ventilating the building from their existing central boiler plant. This boiler plant, located in an adjacent building, consists of three 170 hp. horizontal return tubular boilers equipped with underfeed stokers.

Steam, generated at 100 lb. gauge, is distributed through a 6 in. high pressure main extending from the boiler plant to the new building under the track level floor. From the 6 in. main and running along the ceiling of the track level floor, connections are made through three expanded outlet type pressure reducing valves and serve independently the three systems of low pressure mains as designed for all fan heater coils and direct radiation.

Steam service for the kitchen during summer months is provided for by means of a 40 hp. high pressure vertical steam boiler located on track level floor directly below the kitchen. Domestic hot water steam coils are also served by this boiler.

All high pressure mains for heating system are dripped through traps at low points and returned by gravity through separate returns to a vented receiver located in the boiler room.

All low pressure returns from the three heating systems are dripped and returned to the boiler room vented receiver by means of a battery of four cross-connected return and vacuum pumps. Each of these pumps has a rated capacity of water 22 g.p.m. and 9 c.f.m. of air and is direct connected to an automatically controlled 3 hp. motor. Boiler room feed pumps handle the condensation of the system from the vented receiver tank.

Expansion and contraction throughout is provided for with loops and offsets. Eighty-five per cent magnesia is used for insulating piping systems, 1 in. thick for low pressure and 2 in. thick for high pressure while the returns are covered with 4-ply air cell covering.

Approximately 18 tons of steam and condensate piping is installed throughout the building.

Heating Layout

A two-pipe steam and vacuum return circulating system is used, the piping system being figured for 1 lb. steam pressure drop. Approximately 20,000 sq. ft. of equivalent direct radiation is installed. Full automatic heat control is provided throughout the building.

Designing Water Supply Piping fo

The author has formulated a universal rule which can be used in the design of water piping for buildings ranging in size from the six-family apartment to the tallest skyscraper, for hot water piping as well as the piping supplying cold water fixtures.

Some of the data here presented have never before been published, and are the result of a survey made by the author among leading engineers and architects, modified somewhat to agree with his own experience.

The method here outlined is quite simple, and complete examples show how the rules can be applied.

IN no other branch of our science where piping is involved do we have so little data on the quantity that may be flowing upon which to base estimates of pipe sizes as for water supply pipe in buildings. The great variation in what data there are renders them almost useless. Metered results in one building often show two or three times that in another similar building of the same size and with the same type of tenants. In the same hotel one riser may have an almost constant flow that may never be reached by some other riser in the same building at peak load. In office buildings the women's toilets generally show a far greater daily consumption than do those of the men, yet at no time will they approach the hourly consumption of the men's toilets during the first hour of the day.

This condition has led to a multiplicity of rules of practice which vary as much as the data themselves. All must, of necessity, be based on an assumed rate of consumption and on an assumed probability of simultaneous use and while the rule may have a sound technical basis, the assumption may be dangerous. Even a mathematical estimation of diversity or simultaneous flow must be based on some assumed number of operations per unit of time.

One of the most frequent causes of failure, and probably the most dangerous, is the excessive loss of pressure in the mains or risers. An excessive pressure drop in the cold water riser may allow hot water to cross into the cold water pipe through some duplex faucet. Cases have been known where the loss has been so great as to produce a suction, thus siphoning polluted water into the piping through some submerged discharge opening. This pressure drop is not always due to a restricted riser or main, but may sometimes be due to an oversized branch discharging the water at a greater rate than originally intended or for which the riser was designed to carry.

Column A of Table 1 gives the branch sizes generally recommended for the various fixtures. Column B of the same table gives the generally recommended quantities desired for the fixtures, and Column C the amounts that probably will flow through the branch estimated on a basis of 5 gal. per min. through a ½ in. pipe which is a fair average for this size pipe through the average length of branch. If the pressure at the branch take-off could be exactly determined it would be an easy matter to proportion the branch to deliver approximately the amount desired but, due to an uncertain consumption, this pressure is uncertain and leads to the empirical adoption of sizes for the different fixtures.

TABLE 1

BRANCH PIPE SIZES AND QUANTITIES FOR VARIOUS FIXTURES

Type of Fixture	*A* Pipe Size *In.*	*B* Desired Discharge *Gal. per Min.*	*C* Probable Discharge *Gal. per Min.*
Lavatory	½	4	5
Bath	¾	15	14
Shower, R.H.	½	8	5
Shower Needle	1	30	28
Tank Urinal	½	6	5
Tank Water Closet	½	8	5
Urinal F.V.	¾	30	14
Urinal F.V.	1	30	28
Water Closet F.V.	1	30	28
Water Closet F.V.	1¼	30	49
Slop sinks	1	15	14
Kitchen sinks	½	5	5
Laundry	¾	15	14

Values for Column C have been taken from the equivalent value of pipes of different diameters from Table 2, and based on a discharge of 5 gal. per min. from a ½ in. pipe.
F.V. = Flush Valve R.H. = Rain Head

The rate of discharge will then of necessity vary with the size of branch used. The carrying capacity of the different size pipes varies as $D^{5/2}$ and their values are given in Table 2, taking the capacity of a ½ in. pipe as unity.

An ideal condition in a downfeed riser would be to have the friction loss or pressure drop per floor exactly equal to the pressure gained. Thus, in Fig. 1, starting with an initial pressure of 20 lb. per sq. in. at the tenth

TABLE 2

EQUIVALENT PIPE SIZES

Number of ½ in. pipes accommodated by a single pipe at the same friction loss per unit of length. Based on $D^{5/2}$, using nominal sizes.

Pipe Dia., In.	½	¾	1	1¼	1½	2	2½	3	3½	4	5	6	8
Capacity	1	2.7	5.5	9.7	15.3	32.0	55.0	86.5	127.0	178.0	310	490	1000

for Buildings

By FRED W. HANBURGER†

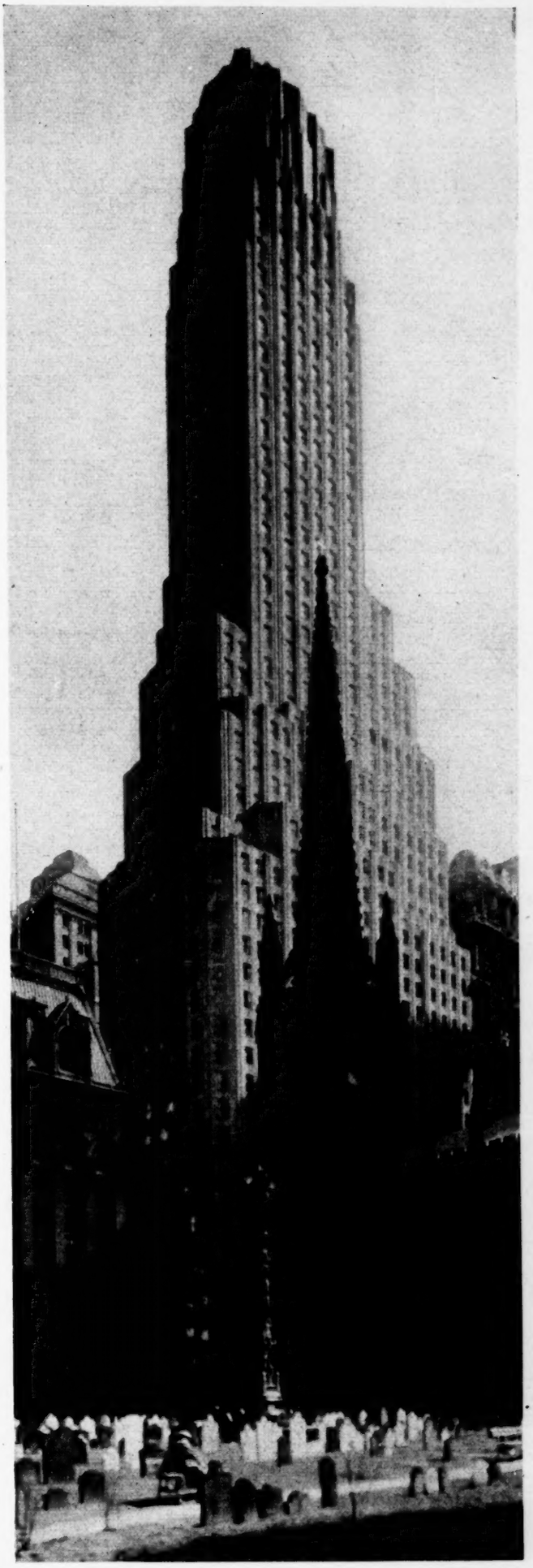
floor, the static pressure at the ninth would be approximately 24 lb. per sq. in., but with 4 lb. per sq. in. friction loss for each floor the remaining pressure would again be 20 lb. per sq. in. Similarly, we would have an available pressure of 20 lb. per sq. in. at each floor and the discharge from all fixtures would be equal with the same diameter branch pipe.

It is impossible to attain this condition in our supply piping owing to the uncertain flow and uncertain friction loss and it may vary from the lowest estimated pressure to a maximum static head. At this higher pressure the discharge from any fixture can be several times greater than normal, creating a great sudden drain on the riser. In the case of a hand operated basin faucet the discharge would not be greatly increased because the splashing discharge would cause the user partially to close the valve. With automatic faucets and flush valves this is different. When open they are wide open and will discharge as much as the pipe diameter and pressure will allow.

The average closet bowl will be properly scoured with 4 1/3 gal. used per flush furnished at the rate of 30 gal. per min. The time consumed in a flushing should then be $\frac{4\ 1/3}{30}$ = approximately 1/7 min., or 9 sec. There are often cases where this discharge occurs in less than 3 sec. of time or at the rate of over 90 gal. per min., more than three times the allotted amount and causing more than nine times the allowable friction loss. This is sometimes sufficient to use up all the available pressure head.

Fig. 2 illustrates the result that may occur with a restricted riser or with oversized branches. With a flushometer valve open on the second floor and discharging all the water that the small riser can supply, the pressure in the cold water riser on the third floor will be

†College of the City of New York.



The Irving Trust Building, New York, designed by Voorhees, Gmelin & Walker, is supplied with about five thousand gallons of hot water per hour, heated through 130°. One hundred and fifty thousand gallons of water per day flow through the water supply system, which consists of three miles of drain and vent pipe and four miles of water supply piping. A piping system as complicated as this could have been designed according to the method outlined by the author.

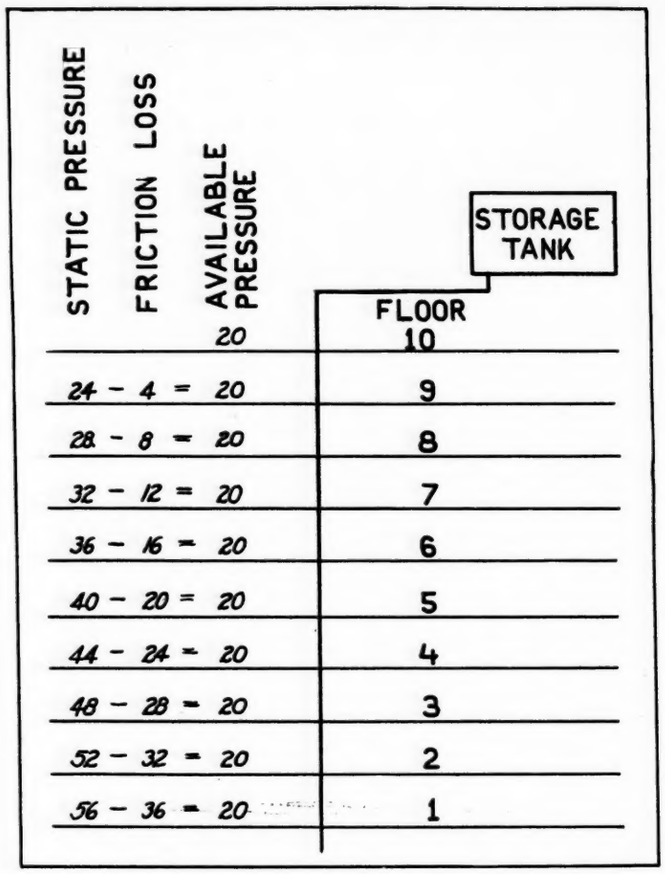


Fig. 1. Ideal pressure condition with downfeed system.

nearly zero and that on the first floor will be only that produced by the height of one floor. If, at this moment, one were taking a shower through a mixed discharge on the third floor he would be met with a hot discharge of untempered water. If the pressure on the third floor were reduced to less than the back pressure of the shower head the hot water would be forced into the cold water line and through the toilets on the floors below.

Again, taking the cold riser only into consideration it can be readily seen that with the third floor taking all the water that the riser can carry, a faucet opened on the first floor would create a suction on the second floor which would siphon water from a basin or bowl through a submerged discharge opening.

While the following facts are no doubt well recognized it seems advisable to keep them in mind while designing a water supply system:

(a) Liberal sizing of the mains and risers will help greatly,
(b) Liberal sizing of the branches may cause trouble,
(c) When liberally sized branches are used, the risers, mains and tanks should be increased accordingly,
(d) With proper care the risers and mains need not be made so large as to make the cost excessive,
(e) To base the design on an assumed probability of simultaneous use may be dangerous.

To arrive at some safe standard and approach some universality in a rule of practice an anaylsis was made of installations that have been known to function satisfactorily. From these a composite system consisting of hospital, hotel and apartment risers was submitted to several engineers, architects and plumbing contractors for comment and modification, the design leaning somewhat more toward safe performance rather than to economic consideration. From the composite plan, the number of ½ in. outlets that each branch and riser was supplying from its position in the layout was noted. The results show a diversity of flow following closely along the curve shown in Fig. 3, the simultaneous use being almost 100% at the last floor supplied (the first floor), diminishing somewhat rapidly as a few succeeding floors are added after which the decline becomes less rapid, approaching a minimum of 10%.

Flow in any one riser is, of course, intermittent and sporadic, but as a number of risers are added the flow becomes rather constant, probably considerably less than 10% of the total. However, the value of 10% seems to be the safe average to take for the flow that may occur at some peak load.

An equation to fit the curve in Fig. 3 may be written

$$P = \frac{224}{F+2} + 10, \text{ where} \qquad (1)$$

P = per cent of simultaneous use, and
F = the number of floors being supplied.

Thus, for a riser supplying *on each floor*:

2 Water closets with 1¼ in. pipe,
2 Baths with ¾ in. pipe and
2 Lavatories with ½ in. pipe

the probable discharge per floor as taken from Table 1 will be

2 Water closets— 98 gal. per min.
2 Baths — 28 gal. per min.
2 Lavatories — 10 gal. per min.
Total.....136 gal. per min. per floor.

At the fifth floor, as an example, the amount flowing in the riser will be

$$5 \times 136 \text{ gal.} = 680 \text{ gal. per min.}$$

The per cent of simultaneous use at the fifth floor from equation (1) is

$$\frac{224}{5+2} + 10 = 42\%$$

and the riser at this point must be designed to carry 0.42 x 680 gal = 286 gal. per min. at whatever friction loss the system will allow. (An example is given later in the text.)

At the tenth floor the flow will be:

$$10 \times 136 \times \left[\left(\frac{224}{10+2} + 10\right)\text{per cent}\right] = 394 \text{ gal. per min.}$$

In a ten story building with 22 similar risers the main would take care of a flow of

$$\frac{224}{(10 \times 22)+2} + 10, \text{ or } 11\% \text{ of the total.}$$

To design the riser with a predetermined pressure drop is not precisely possible owing to a lack of variety in the commercial sizes. Thus, when a certain size is first used the friction must be somewhat less than the specified amount but will increase as the burden increases until the friction is a like amount in excess of that desired before size is again increased. The average drop throughout the range will then approximate the specified loss.

By noting the number of ½ in. fixtures that each

pipe was supplying from its position in the system the schedule as given in Table 3 was constructed. It lends itself readily to designing any other layout of a similar nature.

TABLE 3

Number of ½ in. pipes accommodated by a single pipe in the average type building with allowance for simultaneous use.

Pipe Dia.	*Number of ½ in. pipes*
1	3 to 5
1¼	6 to 11
1½	12 to 44
2	45 to 100
2½	101 to 220
3	221 to 430
3½	431 to 700
4	701 to 1200
5	1201 to 2400
6	2401 to 5000
8	5000 up

An application of the method is shown in Fig. 4 which is the layout of the *upper* half of a 22-story structure consisting of typical office, hotel, club and apartment risers.

Cold water riser No. 1 supplies each floor with 2 water closets with 1¼ in. connections, 2 baths with ¾ in. connections and 2 lavatories with ½ in. connections. Cold water riser No. 2 supplies the same fixtures except that only 1 in. fixtures are used on the closets.

The total factor value per floor for the cold water riser as taken from Table 2 is

2 x 9.7 = 19.4 for water closets,
2 x 2.7 = 5.4 for baths and
2 x 1.0 = 2.0 for lavatories,
a total of 26.8 per floor.

For the first floor (the 12th story in this case) the riser must supply 26.8 ½ in. fixtures, the riser at the second floor 53.6 ½ in. fixtures, the third 80.4 ½ in. fixtures, etc. These and similar values are shown in Fig. 4. By referring to Table 3 the pipe sizes are readily determined from the factor values. These are also shown in the figure.

Hot water riser No. 1 will supply the baths and lavatories only and therefore has a factor value of only 5.4 + 2.0 = 7.4 per floor and is sized similarly.

Since No. 2 riser is exactly similar to No. 1 riser except that only one inch connections are used for the flushometer connections, the discharge to the water closets will therefore be at a lower rate and will need a correspondingly smaller riser. The cold water factor per floor for this floor is thus 18.4. Hot water riser No. 2 will be the same as that of No. 1.

The method is simple, but special cases arise where engineering judgment must still be exercised and attention is called to the difference in design between risers Nos. 3 and 4. On cold water riser No. 3 we have 6 water closets, 4 urinals and 4 lavatories with a combined fixture value of 73.0 per floor, but since the time consumed per flushing is small the diversity factor will be the same as other risers of the system and the regular method is followed. On cold water riser No. 4, however, while the 12th, 13th, 14th and 18th to 22nd floors have 2 water closets, 2 urinals and 1 lavatory with a fixture value of 25.8 per floor, the 15th, 16th and 17th floors have 6 rain head showers, 6 needle showers, 4 water closets, 4 urinals and 3 lavatories per floor. The water closets, urinals and lavatories would have the usual diversity of use, but if it is suspected that the showers will have periods when they will be crowded and in almost constant use it will be necessary to make the branch almost full size and, of course, the riser correspondingly larger. The factor values that will follow the usual diversity are

4 water closets	= 38.8
4 urinals	= 10.8
3 lavatories	= 3.0
Total	52.6

The unusual factors are:

6 rain head showers	= 6.0
6 needle showers	= 33.0
Total	39.0

Since the showers must be given almost a full supply,

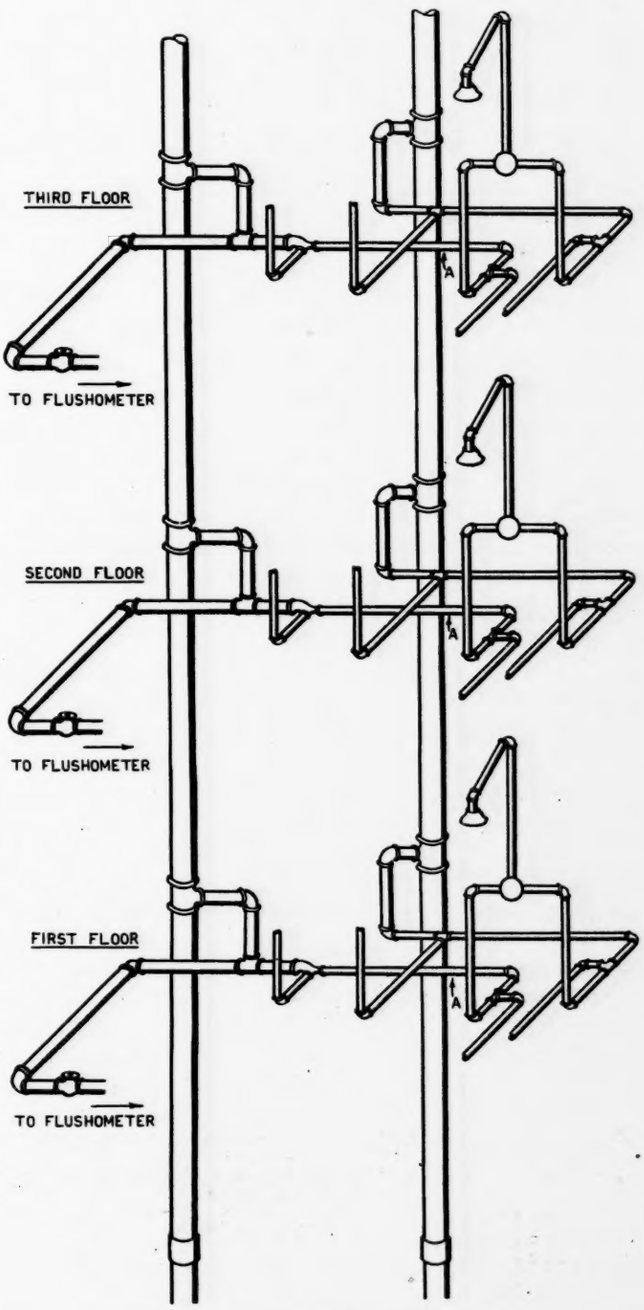


Fig. 2. Layout of riser and branches.

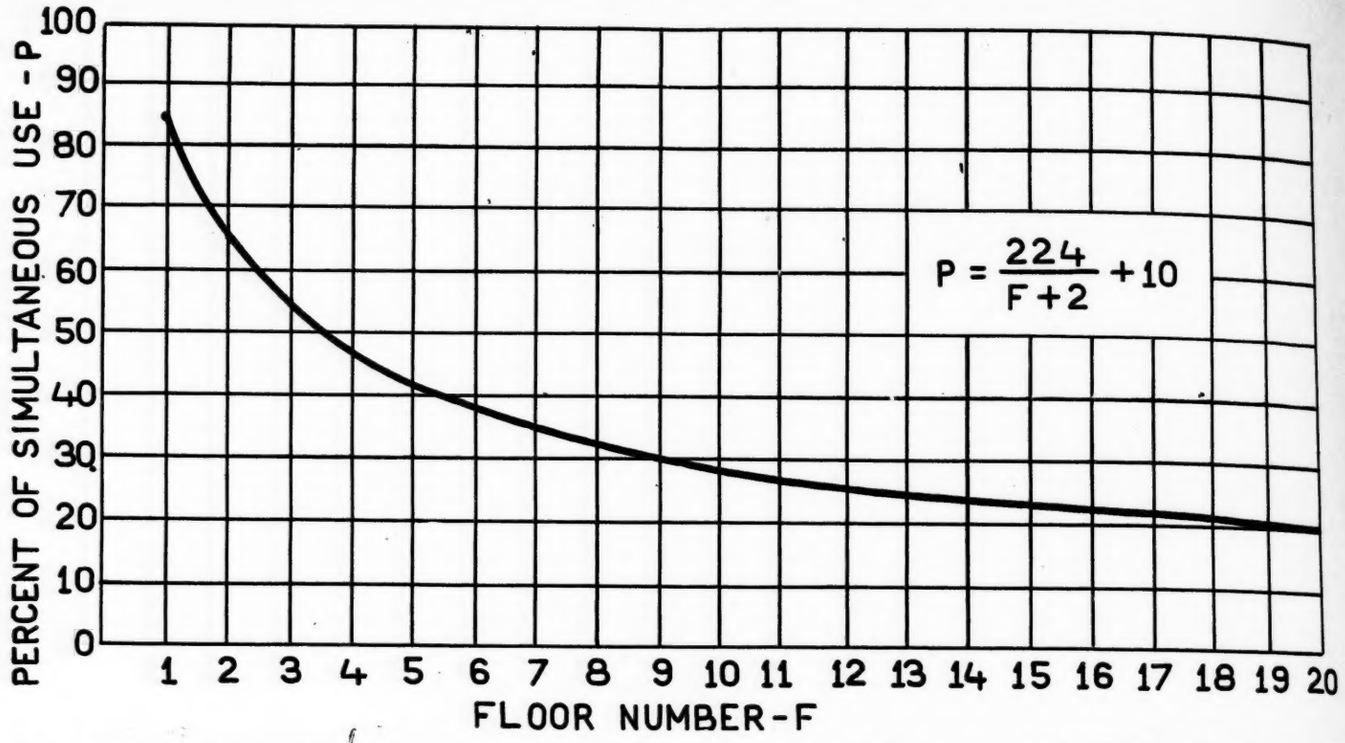


Fig. 3. Graph showing relation between floor number and per cent of simultaneous use of installed fixtures for use in proportioning mains, risers or headers. The floor number is taken as the floor nearest the ground for downfeed systems and the highest floor when an upfeed system is used.

the pipe size to supply them must be taken from Table 2 which indicates a pipe slightly larger than a 2 in. pipe. If the size has been taken from Table 3, a 1½ in. pipe would have been used. Adopting the 2 in. pipe instead of the 1½ in. we must increase the value to be used in the diversity table by the difference in the carrying capacity of the two pipes as taken from Table 2. This is

$$32.0 - 15.3 = 16.7, \text{ or roughly } 17.0.$$

The fixture value for the floor should then be taken as

$$52.6 + 39.0 + 17.0 = 108.6$$

and entering the diversity table (Table 3) with this amount it is noted that a 2½ in. branch pipe should be used. The fixture value of 108.6 is then added to size the riser for the 16th and 17th floors, as shown in Fig. 4. A similar increase is made for the hot water riser.

To size the headers for either the hot or cold water it is only necessary to total the values for all the risers that they supply and take the pipe size from Table 3 as was done in sizing the risers themselves. Thus at A (Fig. 4) it is found to be a 3½ in. pipe, at B the fixture value comes near the dividing line between the 4 in. and 5 in. pipes. If the roof tank is at a high elevation giving considerable pressure the 4 in. pipe might be sufficient. If there is but a small initial pressure it may be advisable to use the larger size.

To determine what loss of pressure may occur at this point where the supply for three risers to 11 floors each is flowing we can consider the third floor as the 33rd floor, and by the use of the formula find that the flow at some peak moment is

$$\frac{224}{33+2} + 10 = 17\%$$

of the actual total fixtures supplied.

The total number of fixtures at this point is 1300 and a flow sufficient to supply

$$0.17 \times 1300 = 221 \text{ fixtures.}$$

Using the value of 5 gal. per fixture the flow at B may sometimes reach

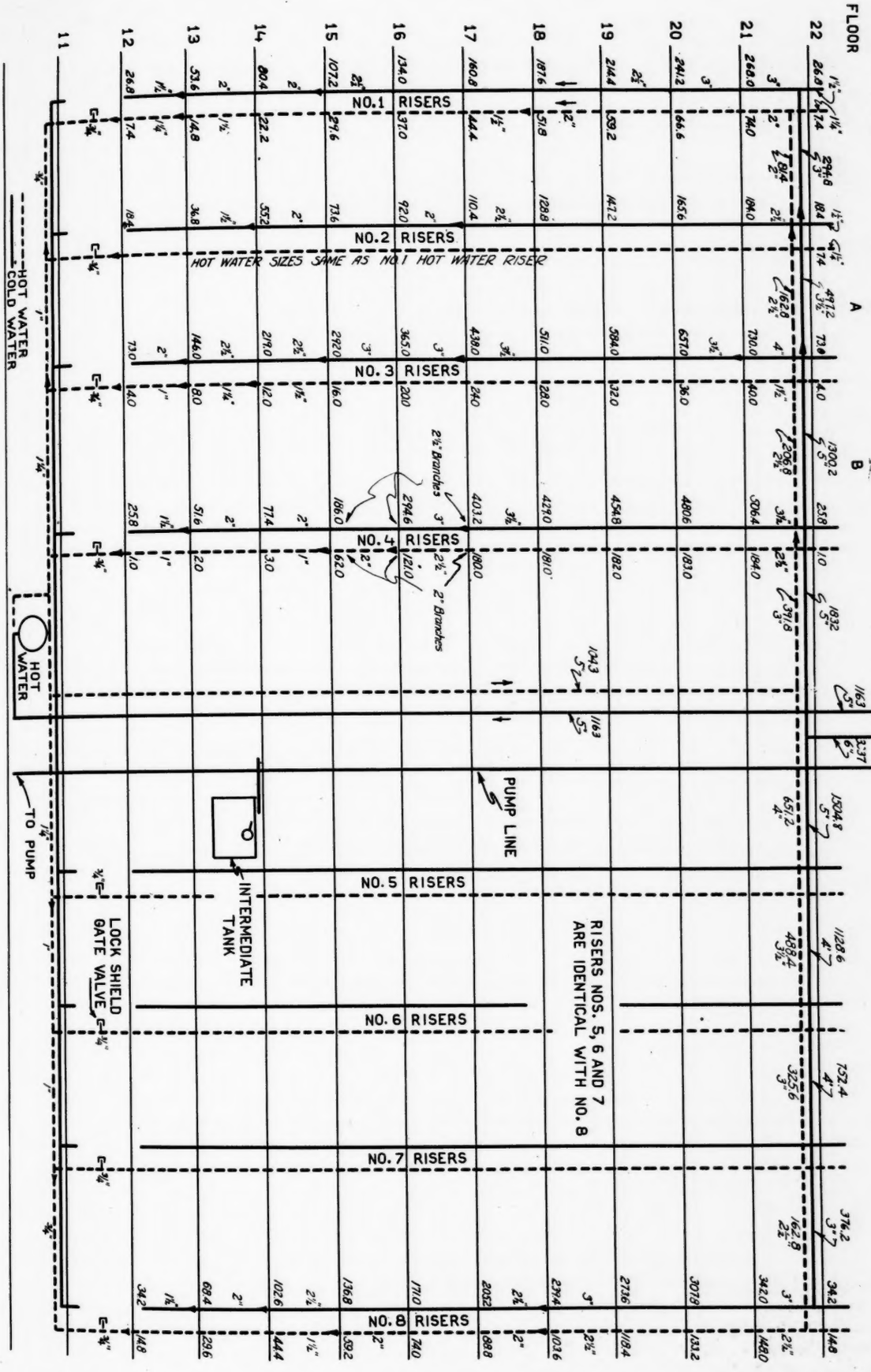
$$5 \times 221 = 1105 \text{ gal. per min.}$$

Referring to Table 4 it is found that the friction loss

TABLE 4

Amount of Water in Gallons per Minute Which Will Flow Through Various Sized Pipes for Various Pressure Drops

Friction Pressure Drop Lb. per Sq. In. per 100 ft. Run	Pipe Size in In.									
	¾	1	1¼	1½	2	2½	3	3½	4	5
5	5.4	11	19	30	62	109	171	252	353	610
7	6.4	13	23	36	74	129	203	298	418	722
10	7.6	15	27	43	88	154	242	357	499	862
20	10.8	22	38	61	125	218	343	504	706	1220
30	13.2	27	47	76	153	267	420	618	864	1495
40	15.0	31	54	86	176	308	485	714	998	1725
50	17.0	35	60	96	197	345	542	800	1115	—
75	21.0	43	74	117	242	423	665	978	1365	—
100	24.0	49	85	136	278	485	769	1130	1578	—
125	27.0	55	96	152	311	544	858	1260	1765	—
150	30.0	60	105	166	341	598	939	1380	1930	—



Riser 1
Factor Values
Fixtures per Floor

2 Closets 1¼ in.	19.4
2 Baths ¾ in.	5.4
2 Lavatories ½ in.	2.0
(Cold Water)	26.8
(Hot Water)	7.4

Riser 2
Factor Values
Fixtures per Floor

2 Closets 1 in.	11.0
2 Baths ¾ in.	5.4
2 Lavatories ½ in.	2.0
(Cold Water)	18.4
(Hot Water)	7.4

Riser 3
Factor Values
Fixtures per Floor

6 Closets 1¼ in.	58.2
4 Urinals ¾ in.	10.8
4 Lavatories ½ in.	4.0
(Cold Water)	73.0
(Hot Water)	4.0

Riser 4
Factor Values
Fixtures per Floor
Floors 15-17

6 R. H. Showers	6.0
6 Needle Showers	33.0
4 Closets 1¼ in.	38.8
4 Urinals ¾ in.	10.8
3 Lavatories ½ in.	3.0
(Cold Water)	91.6
Allowance	17.0
(Cold Water)	108.6
(Hot Water)	42.0
Allowance	17.0
(Hot Water)	59.0

Riser 4
Floors 12-14 and 18-22

2 Closets 1¼ in.	19.4
2 Urinals ¾ in.	5.4
1 Lavatory ½ in.	1.0
(Cold Water)	25.8
(Hot Water)	1.0

Factor Values for Risers 5, 6 and 7 same as for Riser 8.

Riser 8
Factor Values
Fixtures per Floor

2 Closets 1¼ in.	19.4
2 Baths ¾ in.	5.4
2 Lavatories ½ in.	2.0
2 Sinks ½ in.	2.0
2 Laundries ¾ in.	5.4
(Cold Water)	34.2
(Hot Water)	14.8

Fig. 4. Pipe sizes and quantities of water for solution of water supply piping problem.

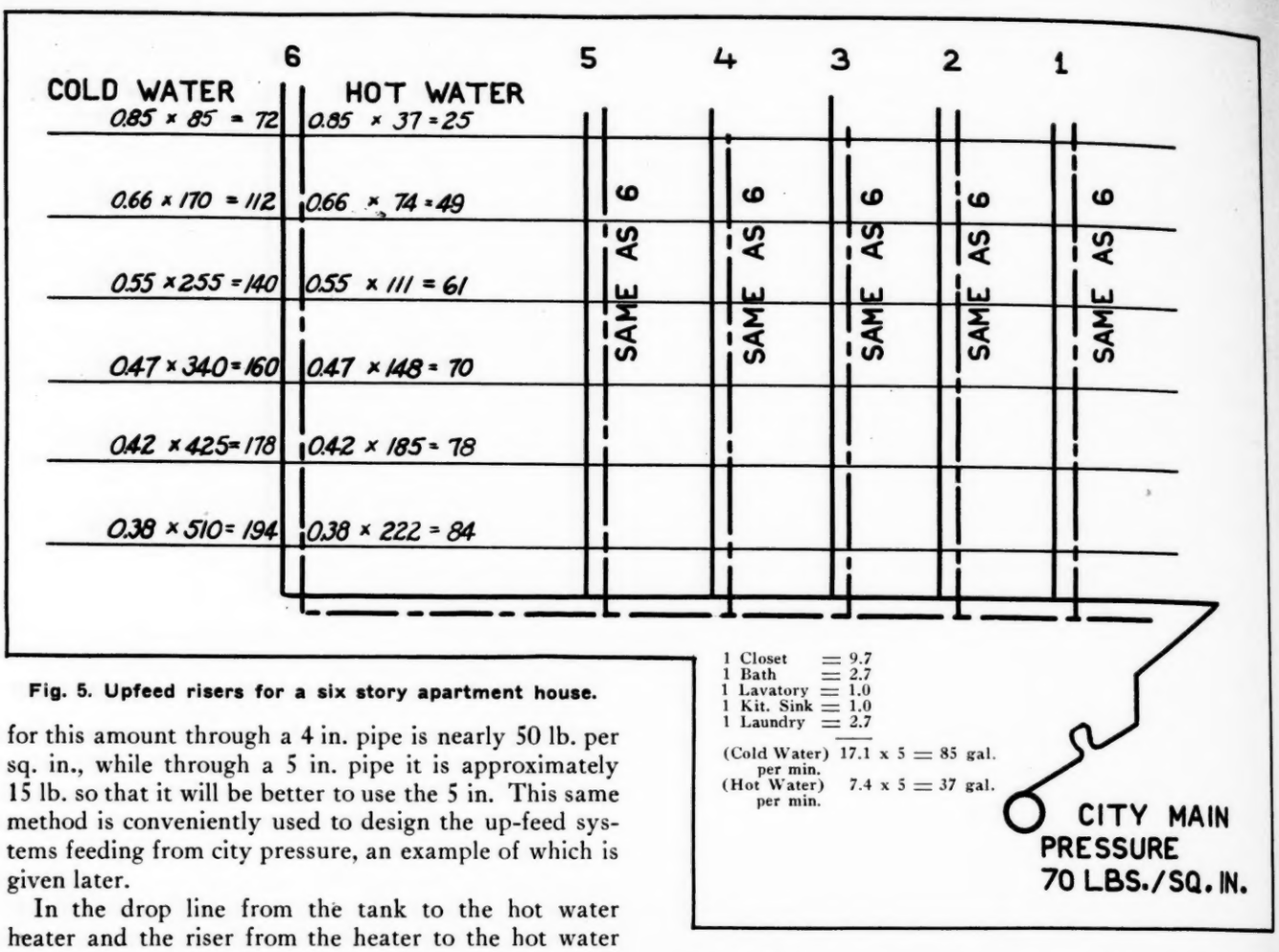

6
5
4
3
2
1
COLD WATER
HOT WATER
0.85 × 85 = 72
0.85 × 37 = 25
0.66 × 170 = 112
0.66 × 74 = 49
0.55 × 255 = 140
0.55 × 111 = 61
0.47 × 340 = 160
0.47 × 148 = 70
0.42 × 425 = 178
0.42 × 185 = 78
0.38 × 510 = 194
0.38 × 222 = 84
SAME AS 6
SAME AS 6
SAME AS 6
SAME AS 6
SAME AS 6
1 Closet = 9.7
1 Bath = 2.7
1 Lavatory = 1.0
1 Kit. Sink = 1.0
1 Laundry = 2.7
(Cold Water) per min. 17.1 x 5 = 85 gal.
(Hot Water) per min. 7.4 x 5 = 37 gal.
CITY MAIN PRESSURE 70 LBS./SQ. IN.

Fig. 5. Upfeed risers for a six story apartment house.

for this amount through a 4 in. pipe is nearly 50 lb. per sq. in., while through a 5 in. pipe it is approximately 15 lb. so that it will be better to use the 5 in. This same method is conveniently used to design the up-feed systems feeding from city pressure, an example of which is given later.

In the drop line from the tank to the hot water heater and the riser from the heater to the hot water header on the 21st floor there are approximately 200 lin. ft. of pipe. If too much friction is lost through it there will be too great a difference in the pressures at the cold and hot water fixtures on the different floors. All the hot water for the 8 risers feeding 11 floors each, or 88 floors in all, and supplying 1043 ½ in. fixtures must flow through it. Owing to the diversity factor we may expect a maximum flow at some time of

$$1043 \text{ fixtures} \times 5 \text{ gal.} \times \left(\frac{224}{88+2} + 10\right)\% = 652 \text{ gal. per min.}$$

From Table 4 it is found that the loss for this amount flowing through a 5 in. pipe is less than 7 lb. per sq. in. per 100 ft. of pipe.

Attention is called to the fact that the headers on the 21st floor supply the fixtures on the 22nd floor through upfeed branches. Similarly, the headers on the 10th floor supply the fixtures on the 11th. This provides an outlet for any air that may be trapped in the system. The hot water risers are connected to a return header for gravity circulation. The connections are of ¾ in. pipe and there is no need to have them larger as the circulating flow need not be great but it should flow equally through every riser. To accomplish this it is advisable to install a lock shield gate valve in the small connection which can be adjusted to equalize the circulation.

Branch Pipes

Most valves will deliver the quantity listed in Column C, Table 1, with a pressure of 6 lb. per sq. in. at the valve. This does not mean the static pressure but the pressure that may exist while the water is flowing. Thus, if there were a static pressure of 15 lb. per sq. in. at the branch take-off the branch piping should be made to consume 9 lb. per sq. in. in friction. If a pressure of 40 lb. existed the branch should consume 34 lb. in friction. As has already been stated the pressure at the take-off is variable and its estimation will be uncertain.

The average length of branches is about 15 ft. which, with the fitting resistance, gives an approximate equivalent length of 25 ft. With the tappings used as specified in Table 1 the loss in the branch then will be 8 lb. per sq. in. when delivering the amount given in Column C of the same table. If the actual length of the branch then should greatly exceed 15 ft. or if the available pressure is greatly below 15 lb. per sq. in. the branch should be made one size larger than that specified in Table 1.

To design an upfeed system as fed from city pressure, assume a six-story apartment building with 6 risers as shown in Fig 5, and with a pressure in the street main of 70 lb. per sq. in. The static, or constant, pressure due to the height of the upper fixture above the main (taken here as 60 ft.) will be 26 lb. per sq. in., leaving 44 lb. available for friction and operation.

The next consideration is the friction consumed by the meter. A failure to consider this has often led to sad results since the friction through some types of meters is equal to that throughout the balance of the system. Its value can always be obtained from the manufacturer. In this case it is taken as 15 lb. per sq. in. which leaves 29 lb. still available. Allowing 6 lb.

at the valve and 8 lb. through the branch there are still 15 lb. remaining for the friction in the risers and mains. The length of the risers is approximately 60 ft. which, with an allowance of 50% for fitting resistance, gives an equivalent length of about 90 ft. and the maximum allowable loss in the risers will be

$$\frac{15 \text{ lb.}}{90 \text{ ft.}} = 16+\text{lb. per. sq. in. per 100 ft.}$$

The friction must be somewhat less than this to allow for the loss in the mains. It is best to keep the loss in the mains as low as possible so that the pressure at the foot of each riser will be practically the same. Designing typical riser No. 6 it is noted that the fixture value per floor is 17.1 for the cold water and 7.4 for the hot. At 5 gal. per fixture this gives 85 gal. per floor for the cold water and 37 gal. for the hot. These values are then totaled for each floor and multiplied by the percentage of use for that floor. Thus, for the third floor, counting from the top which in this case is the fourth floor, the flow per minute that may sometimes be expected in the cold water riser is

$$85 \text{ gal.} \times 3 \times \left(\frac{224}{3+2} + 10\right)\% = 140 \text{ gal. per min.}$$

These calculations are all shown in Fig. 5 and the pipe sizes can now be taken from Table 4 so that the pressure loss will be below 16 lb. per sq. in. A similar calculation is shown for the main between risers Nos. 5 and 4, but in this case the pipe size is chosen so that the friction is less than 5 lb. per sq. in.

Storage Tanks

Here again the rules of practice vary greatly. Generally accepted assumptions are that the number of fixtures used simultaneously is equal to one hour's use and to give the storage tank a capacity of from 5 to 10 times this amount. In the case of Fig. 4 there are 3337 cold water and 1043 hot water fixtures, making a total of 4380. The percentage of use for 8 cold water and 8 hot water risers supplying 11 floors each, or 176 floors in all, is about 11% giving a simultaneous use of 482 fixtures. At 5 gal. per fixture this is equal to 2410 gal. which is taken as one hour's storage. A 5 hr. storage would then call for a 10,000 gal. tank and a 10 hr. storage for one of 20,000 gal. The latter size would be the better practice insuring service during any prolonged pump repairs. The above figures do not include the stand pipe or fire storage, which must be governed by the prevailing code.

Hot Water Tanks and Heaters

The fixture method is probably as rational as any to determine the size and heating capacity allowing a factor of safety of 2 to meet the prevailing practice, i.e., taking the peak load flow as a ½ hour supply. In the case of Fig. 4 this gives an hourly supply of

$$5 \text{ gal.} \times 1043 \text{ fixtures} \times \left(\frac{224}{88+2} + 10\right)\% \times 2 = 1300 \text{ gal.}$$

Two 1000 gal. tanks with a heating capacity of 1000 gal. per hr. each would probably be used in the average practice for a building of this size, but one would suffice. In apartment house work it is customary to allow 10 gal. per hr. per apartment that has but one bath and 15 gal. for those with 2 baths. In the case of Fig. 5 this calls for a heating capacity of 360 gal. per hr. By the fixture method, with a value of 7.4 fixtures per floor, the heating capacity would be

$$7.4 \times 36 \text{ apts.} \times 5 \text{ gal.} \left(\frac{224}{36+2} + 10\right)\% \times 2 = 426 \text{ gal. per hour.}$$

In either case a 400 gal. tank with a heating capacity of 400 gal. per hr. could be adopted.

Some designers prefer a larger storage with a decreased heating capacity, but much of the modern practice seems to lean toward a small storage and large heating capacity, making the heaters practically instantaneous.

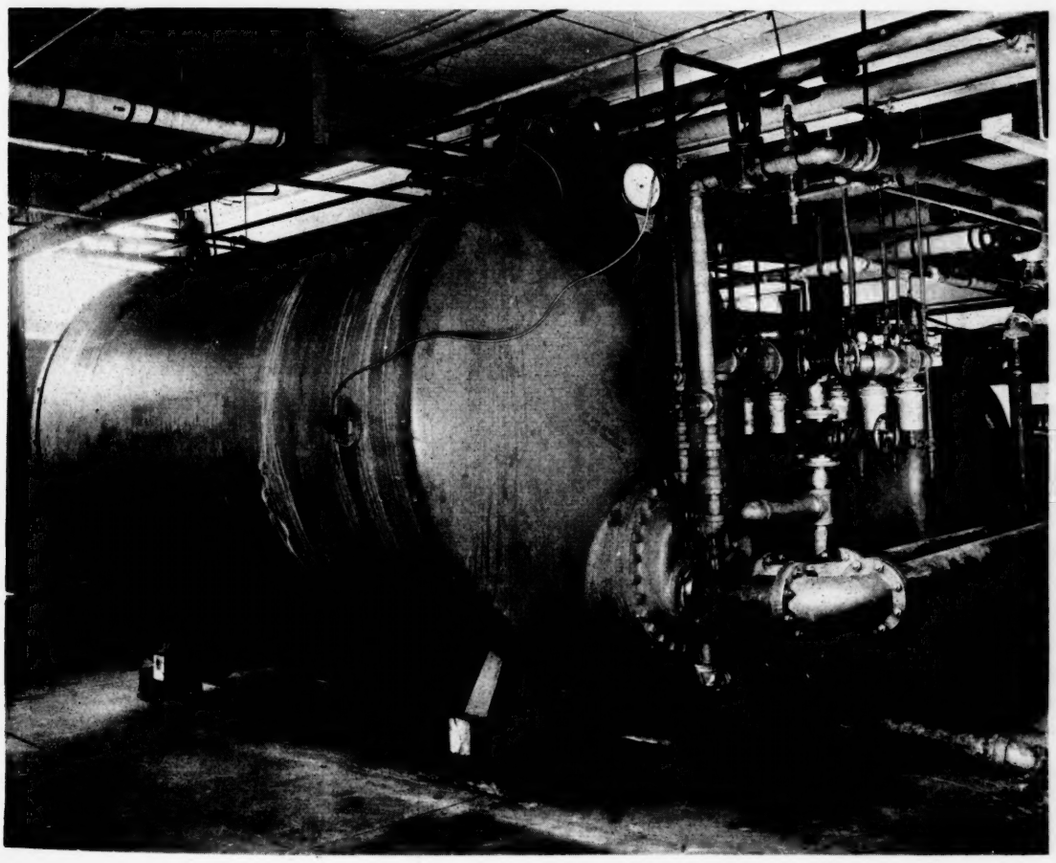


Fig. 6. A typical service hot water heating installation in a large office building.

A Review of Psychrometric Charts

Part II

by C. O. MACKEY†

The Carrier Chart

IN 1911, Willis H. Carrier[4] presented before the A.S.M.E. a psychrometric chart which has been very widely used by heating and ventilating engineers. The primary variables in the net work system in this chart are substantially the same as in the Grosvenor chart. Absolute humidity, in grains of water vapor per pound of dry air, is plotted as ordinate against dry bulb temperature as abscissa, in the primary coordinate system. For a barometric pressure of 29.92 in. of mercury the line representing a relative humidity of 100% is located on this coordinate system in accordance with equation (2) (HEATING AND VENTILATING, June, 1931, page 51) modified to give grains instead of pounds by multiplying by 7000. Instead of locating lines of constant percentage saturation, as in the Grosvenor chart, Carrier placed on the primary coordinate system, lines of constant relative humidity.

At any given dry bulb temperature, the absolute humidity for a relative humidity of R.H. per cent is not exactly equal to $\frac{\text{R.H.}}{100}$ times the absolute humidity for saturation at the given temperature. Hence, the lines of constant relative humidity cannot be located by proportion, as can the lines of constant per cent saturation, and the location of intermediate points on the lines of constant relative humidity must be calculated. As the fourth variable on the primary coordinate system, Carrier used wet bulb temperature locating lines of constant wet bulb temperature in accordance with equation (4) (HEATING AND VENTILATING, June, 1931, page 52). Dew point temperature may be found, as on the Grosvenor chart, for any air condition by first finding the absolute humidity and then extending a line of constant absolute humidity to the left until it crosses the saturation curve. The temperature at the intersection is the dew point. As secondary variables, Carrier plotted total heat, vapor pressure, and dry and saturated air specific volumes. This chart is adapted to the solution of problems in air conditioning, and a typical example will next be solved to explain the use of the chart.

Suppose that a dry bulb temperature of 70°F. with a relative humidity of 60% is to be maintained in an enclosure when the outside air is at 30°F. dry bulb and 25°F. wet bulb with normal barometric pressure. The state of the outside air is shown as *1* on the skeleton chart, Fig. 4, and that of the indoor air at *2*. The primary coordinate system of the chart shows that 66 — 12 = 54 grains of moisture must be added to each pound of dry air and that the humidifier must maintain a dew point of 55°F. Since the "total heat" is a function of wet bulb temperature only, the "total heat" of the outside air at a wet bulb of 25° is found to be 9.3 B.t.u. per lb. of dry air, while the "total heat" of the indoor air, which is at a wet bulb of 61°, is found to be 26.8 B.t.u. per lb. of dry air. Hence, approximately 26.8 — 9.3 = 17.5 B.t.u. must be added per pound of dry air heated.

One recent addition to the Carrier chart is that of lines of constant *effective* temperature.[5] The effective temperature is experimentally determined as an index of human comfort for all combinations of temperature and humidity. At a given effective temperature, human comfort, as affected by temperature and humidity, is supposed to be the same irrespective of the particular combination of dry and wet bulb temperatures that are producing the effective temperature. These effective temperature lines could be added to any psychrometric chart. They simply add a fifth variable to the primary net work scheme of the chart, and are nearly parallel to the wet bulb temperature at high temperatures and to the dry bulb at low temperatures.

M. C. W. Tomlinson has recently[6] presented charts of the Carrier form covering low humidities. On these charts, a range of dry bulb temperature from 20° to 120°F. is covered, and lines of constant relative humidity to 15% by steps of 1% are included.

The Bulkeley Chart

If the logarithm of the saturation pressure of steam be plotted against the temperature, or if the pressure be plotted against the temperature on semi-log paper, the resulting line will be found to be nearly straight, but dropping somewhat from a straight line at high temperature. By progressively decreasing the modulus of the uniform temperature scale at higher temperatures, i.e., by using non-uniform scale, the line can be made exactly straight. In 1926, Claude A. Bulkeley used this information[7] to modify the Carrier psychrometric chart. For this primary coordinate scheme he used vapor pressure, instead of absolute humidity, as ordinate, vs. dry bulb temperature as abscissa. By using a logarithmic abscissa scaling and a non-uniform temperature scale of decreasing modulus, the saturation pressure, or 100% humidity line, is straightened. If the saturation pressure at any temperature be p_d, the vapor pressure at the same temperature for say 10% relative humidity,

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[4] Trans. A.S.M.E., Vol. 34, 1911.

[5] A.S.H.V.E. Guide, 1931, pages 398, 401, 402, 403.

[6] A.S.H.V.E. Jour., Vol. 35, No. 2, Feb., 1929.

[7] Trans. A.S.H.V.E., Vol. 32, 1926.

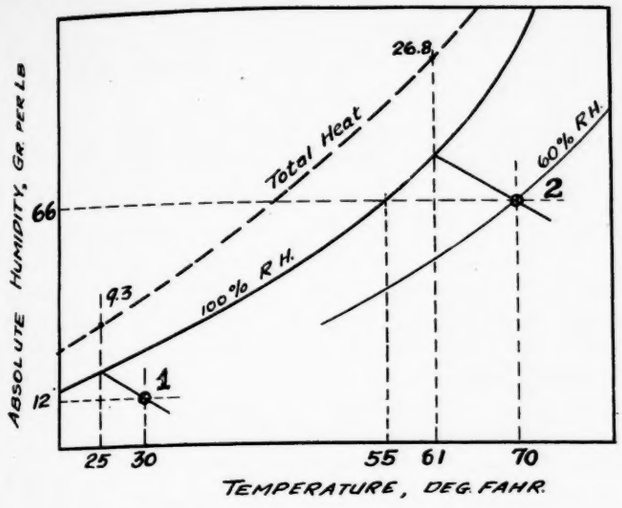


Fig 4. Skeleton drawing of Carrier chart.

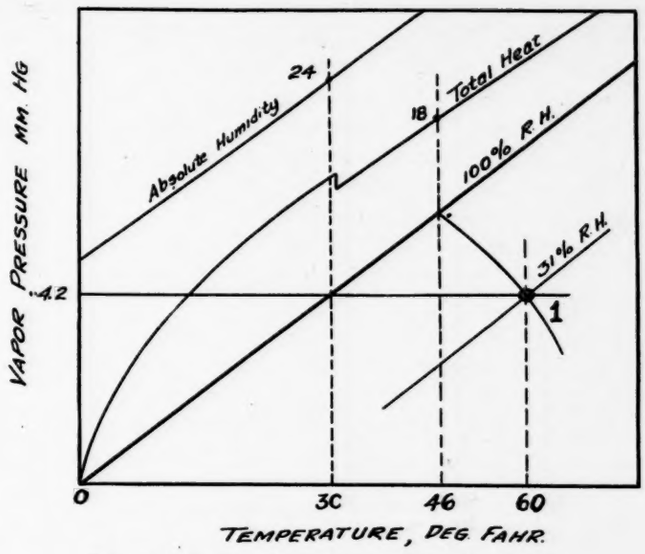


Fig. 5. Skeleton drawing of Bulkeley chart.

is $0.1p_d$, and the lines of constant relative humidity are all straight and parallel to the 100% humidity line, and can be easily located. Lines of constant wet bulb temperature are then added, as before, to the primary coordinate system. These lines, instead of being nearly straight, are now curved. The Bulkeley scheme of plotting, then, straightens the lines of constant relative humidity, but increases the curvature of the lines of constant wet bulb temperature. It permits much greater accuracy in locating state points at low relative humidities and high temperatures than the Carrier chart. Absolute humidity is eliminated as a primary variable in this chart, but a curve of absolute humidity is plotted against temperature for saturation. To find the absolute humidity for any state point, the dew point is first found and then the absolute humidity for saturation at this dew point is read, and this equals the absolute humidity at the first state.

As a suggestion for the possible improvement of the Bulkeley chart, an auxiliary ordinate scale could be added, such that when a state point is located on the primary coordinate system, the absolute humidity could be read directly without first finding the dew point and then carrying up to the absolute humidity line. This would increase the speed and accuracy in using the chart, and is possible since, for any given barometric pressure, the absolute humidity depends only on the actual partial pressure of the vapor in accordance with the following equation:

$$\text{A.H.} = 0.622\ \frac{p}{B-p}\ \text{lb. per lb. of dry air.} \qquad (6a)$$

$$= 4354\ \frac{p}{B-p}\ \text{grains per lb. of dry air.} \qquad (6b)$$

where p is the actual partial pressure of the vapor, and B the barometric pressure, both to be expressed in the same units.

A skeleton chart in Fig. 5 illustrates how the Bulkeley chart may be used to find several important characteristic properties of state, after a state point has been located on the chart. It must be remembered that the values of relative humidity and wet bulb temperature are located on the chart only for a barometric pressure of 29.92 in. of mercury.

Example: For a dry bulb temperature of 60° and a wet bulb of 46° locate state 1 and read relative humidity of 31%, vapor pressure of 4.2 mm. of mercury, a dew point of 30°, a total heat of 18 B.t.u. per lb. of dry air, and an absolute humidity of 24 grains per lb. of dry air.

The Bulkeley chart is very satisfactory as an aid to the solution of air conditioning problems.

The Hill Chart

For all problems in heating and ventilating which fall between dry bulb temperatures of 0° and 120°F., E. V. Hill[8] presented, in 1920, a most satisfactory chart, which is reproduced in Fig. 6.

In the opinion of the author, the arrangement of this chart is a step in the right direction. Doctor Hill removed the variables of secondary importance from the coordinate system. This not only simplifies the appearance of the chart, but he then placed these secondary variables exactly where they belong, viz., *on scales alongside scales of the primary variables upon which they depend.*

The Hill psychrometric chart is triangular in form, but is really a plot of dew point temperature vs. dry bulb temperature, each on a uniform scale. On this primary coordinate system are plotted lines of constant wet bulb temperature and constant relative humidity. Locating a state point on the primary coordinate system by knowing the dry and wet bulb temperatures, the relative humidity and the dew point may be read directly, for a barometric pressure of 29.92 in. of mercury.

It is the treatment of the secondary variables that is novel, however. The legs of the triangle, which the chart forms, carry respectively, uniform scales for wet bulb, dry bulb, and dew point temperatures. Now, alongside each of these legs are scales for the dependent secondary variables. For example, "total heat" depends only on wet bulb temperature. Therefore, along the wet bulb temperature scale is an auxiliary scale for "total heat." As soon as the wet bulb temperature is known, the "total heat" is read directly. The volume, in cubic feet of one pound of bone dry air and of one

[8] Heating and Ventilating, Oct., 1920, page 50.

pound of dry air "saturated" with vapor, depends upon the dry bulb temperature. So scales for these secondary variables are placed alongside the dry bulb temperature scale. As soon as the relative humidity is known, it is possible, also, to interpolate between these scales and secure any humid volume. The absolute humidity, the weight of water vapor per cubic foot of dry air at saturation, and the vapor pressure depend upon the dew point temperature. Scales for these variables are therefore placed alongside the scale of dew point temperature. As soon as the dew point temperature is found, any or all of these three secondary variables can be secured, directly.

The advantage of this treatment of secondary variables should be obvious. It is only necessary to compare this chart with, say, the Bulkeley chart to appreciate the value. Suppose the Bulkeley chart is being used to find absolute humidity and "total heat" from dry and wet bulb temperatures. The state point is located on the primary coordinate system using the abscissa scale as a dry bulb scale. Next, the dew point is secured. Then, the abscissa must be transformed, in the mind, to a scale of dew point temperature, and the absolute humidity read as the ordinate of a curve at this abscissa. To find the "total heat," the abscissa is changed, in the mind again, to a scale of wet bulb temperature and the "total heat" read from a curve. In this problem, then, the abscissa scale is used for three different variables. If the mind slips, "total heat" or absolute humidity may be read over dry bulb temperature, with serious error. Putting each secondary variable on a scale alongside the primary variable, upon which it depends, eliminates the possibility of such error, and furthermore simplifies the appearance of the chart. A person with very little knowledge of psychrometry should be able to use the Hill chart and secure the correct answer to a psychrometric problem at least.

The Heat Exchange Diagram

Another psychrometric chart and heat exchange diagram which has been used is that originally presented by F. I. Weiss in his book *Kondensation*. This chart will be found explained in several publications.[9] In this chart, the primary coordinate system is "total heat," as ordinate, vs. dry bulb temperature, as abscissa. On this coordinate system are drawn lines of constant per cent humidity, and constant absolute humidity. This chart makes "total heat" a primary rather than a secondary variable with the idea of reducing the labor in solving heat exchange problems. However, the chart has little to recommend it, and is not in very wide use at the present time. The Hill chart covers the same range as the so-called Harding chart and is much more satisfactory for general use.

[9] "Mechanical Equipment of Buildings," Vol. I, First Edition, by Harding and Willard; Sibley Journal of Engineering, June, 1919; Trans. A.S.H.V.E., 1912.

All of the psychrometric charts which Professor Mackey has so far discussed have been drawn for a single barometric pressure, 29.92 in. of mercury. Next month, in the concluding installment, he will tell of the Ware chart on which the barometric pressure is variable. Weisselberg's chart will be described and a summary presented.

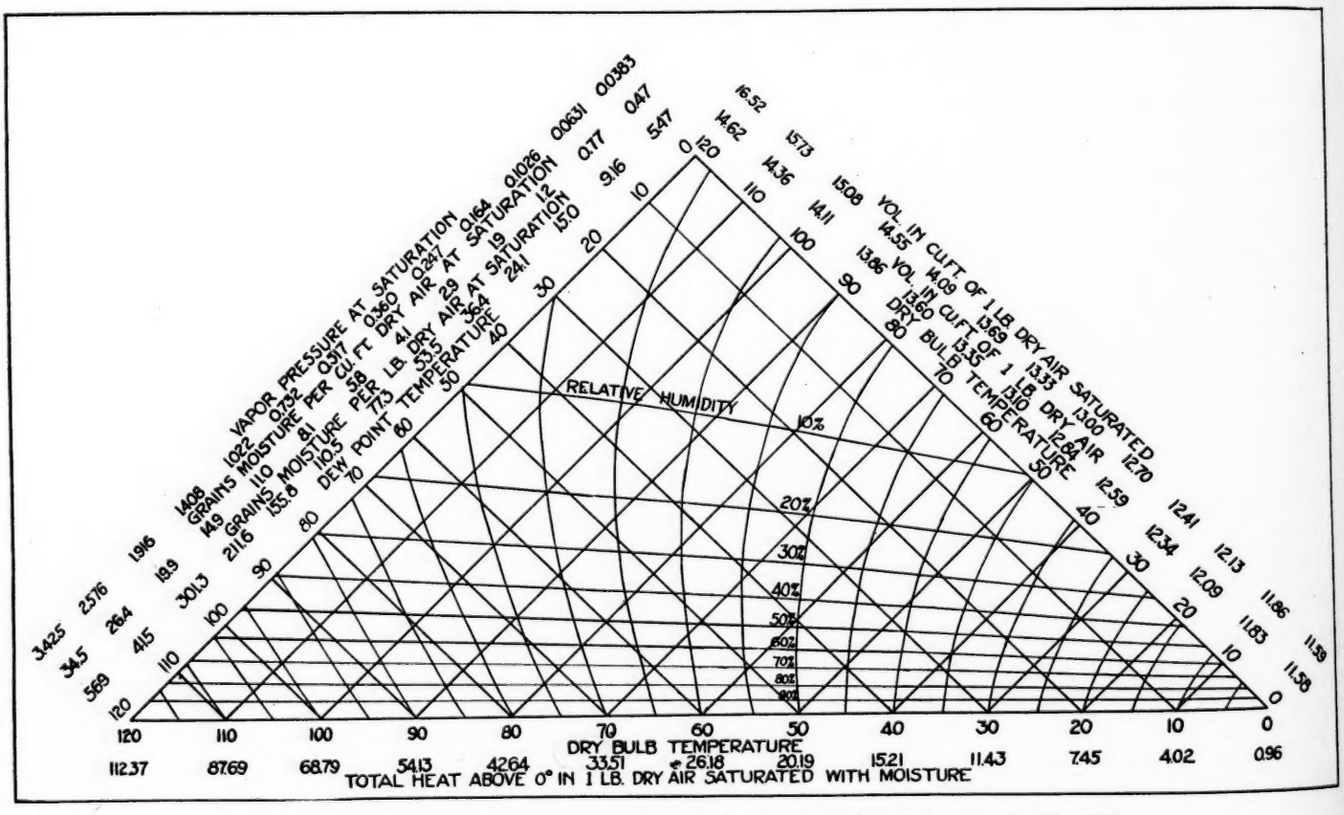

VAPOR PRESSURE AT SATURATION
GRAINS MOISTURE PER CU FT DRY AIR AT SATURATION
GRAINS MOISTURE PER LB DRY AIR AT SATURATION
DEW POINT TEMPERATURE
RELATIVE HUMIDITY
VOL. IN CU FT OF 1 LB DRY AIR SATURATED
VOL. IN CU FT OF 1 LB DRY AIR
DRY BULB TEMPERATURE
DRY BULB TEMPERATURE
TOTAL HEAT ABOVE 0° IN 1 LB. DRY AIR SATURATED WITH MOISTURE

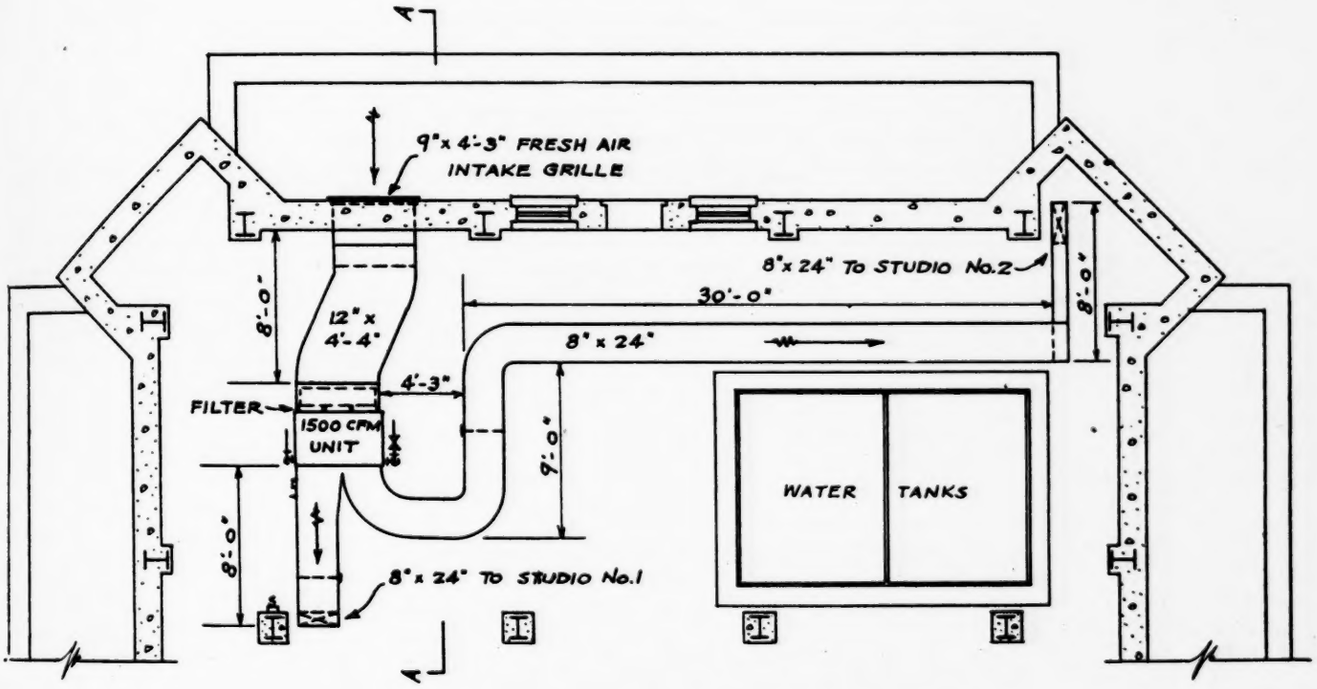
Fig. 6. Skeleton drawing of the psychrometric chart designed by Dr. E. V. Hill.

Mechanical Ventilating Unit Used with Connecting Ductwork

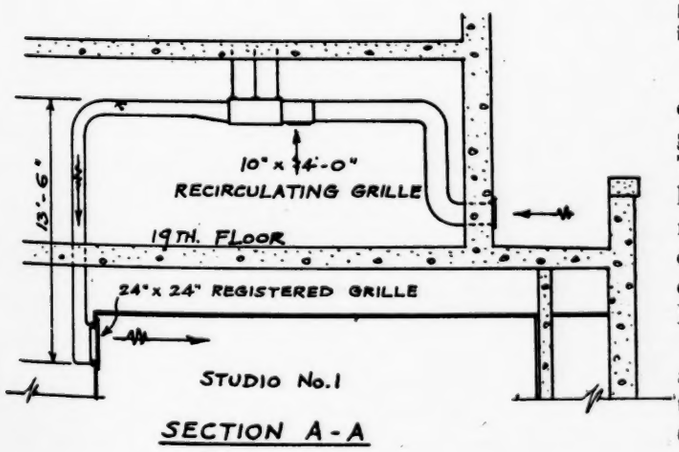
AN unusual application of a unit ventilator is that in the broadcasting headquarters of radio station WCAM, located on the 18th floor of the new Camden County Court House, Camden, N. J. The headquarters consists of two studios and a switchboard room, heated and ventilated by means of fan units located in the machinery room on the floor above. Both studios are interior rooms, sound insulated, and equipped with the most modern radio equipment.

Heated air is supplied from a three-speed 1500 c.f.m. schoolroom-type ventilating unit, suspended horizontally from the ceiling and connected to one supply duct to each studio. Supply grilles are placed in the side walls of the studios near the ceiling. The exhaust grilles are in the ceilings with connecting ductwork to an 1800 c.f.m. exhaust fan located on the floor above. Studio No. 1 contains 5000 cu. ft. and Studio No. 2, 2400 cu. ft.

In conducting a test on the supply unit operating at a high speed with exhaust fan not operating, it was found that the air delivery to Studio No. 1 was 645



PLAN OF 19TH. FLOOR MACHINERY ROOM OVER STUDIOS



SECTION A-A

Plan and section of ventilating scheme in Station WCAM

c.f.m. at the supply grille, and 320 c.f.m. at the supply grille in Studio No. 2—a total air delivery of 965 c.f.m. This indicates a loss in air delivery of 35%, and if the loss through the filter units is assumed to be 8%, there remains a loss of 27% due to the intake and discharge ductwork. The temperature loss through the supply ducts was 2° for Studio No. 1, and the loss for Studio No. 2, 19°.

Both supply ducts are of the same cross-sectional area, and the air delivery to each studio is equivalent to about 8 changes per hr.—*G. Kendrick Bringhurst, Consulting Engineer, Philadelphia.*

Air Conditioning the Ohio Bank Building

By JOHN GILLETT†

Bank quarters occupy the basements and first to sixth floors, inclusive, in the Ohio Bank Building in Toledo. All of this space is air conditioned in accord with the best modern practice. Basements and ground floors are supplied by equipment located in the sub-basement while the main banking room and other floors are handled by equipment on the fifth floor. . . . The text and illustrations apply only to those features of the installation which differ from stereotyped practice.

Ohio Bank Building, Toledo.

ALL of the banking quarters in the Ohio Bank Building, a thirty-story granite and limestone structure in Toledo, are air conditioned. Particular attention was paid to the method of introducing air into the banking rooms to (1) secure even distribution, (2) make the inlets as inconspicuous as possible and (3) avoid all possibility of drafts.

The lower floors of the building serve as banking quarters for The Ohio Savings Bank and Trust Company, while the upper floors are rented. The bank occupies a portion of the sub-basement, basement and first floor, and the entire first, second, third, fourth, fifth and sixth floors.

The main banking room is on the second floor. The central portion of this room has a height of 42 ft. extending through three stories. At the sides of this room the third and fourth floors form wide balconies which provide space for the clerical departments, committee rooms, directors' room, etc.

There are two main groups of central air conditioning apparatus. The sub-basement and basement, including the vaults and the entire ground floor, are taken care of with equipment located in the engine room in the

† Mechanical Engineer, Office of Mills, Rhines, Bellman & Nordhoff, Toledo, Ohio.

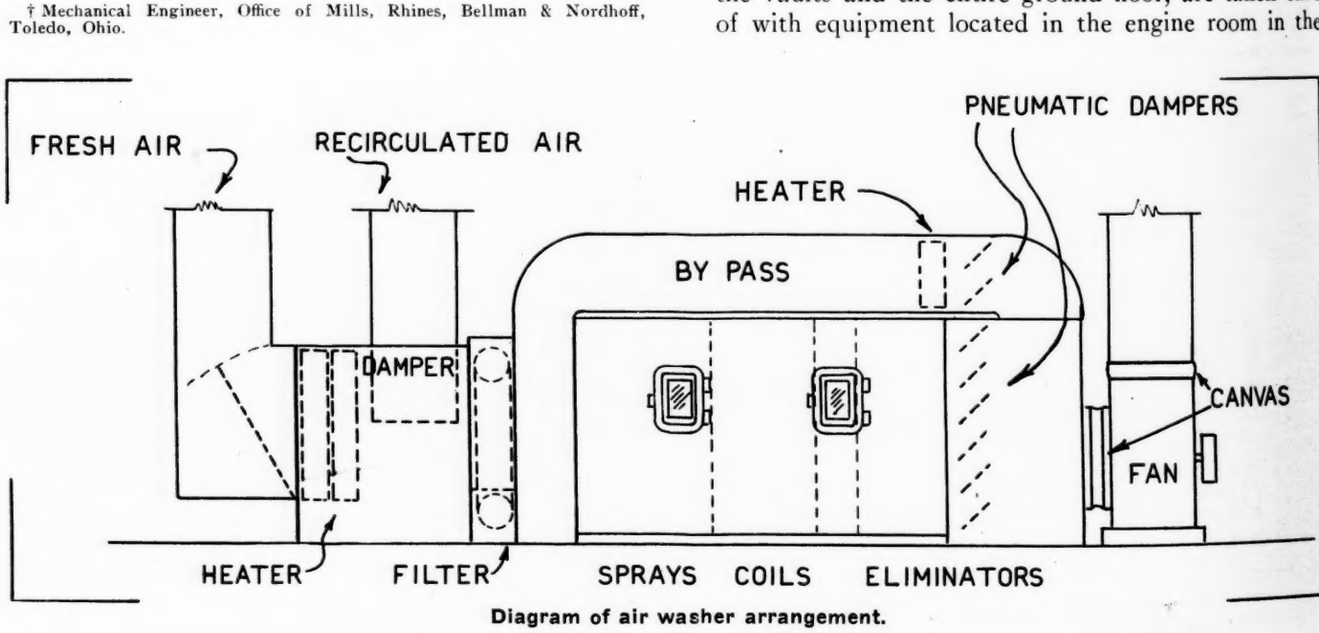


Diagram of air washer arrangement.

View of one of the bookkeeping rooms of the Ohio Bank Building, Toledo.

sub-basement. The main banking room, the third and fourth floor clerical departments, conference and directors' room and the entire fifth floor are handled by equipment located on the fifth floor.

Each of the main groups consists of two units, each unit having a fan, continuous oil filter, air washer and heating coils.

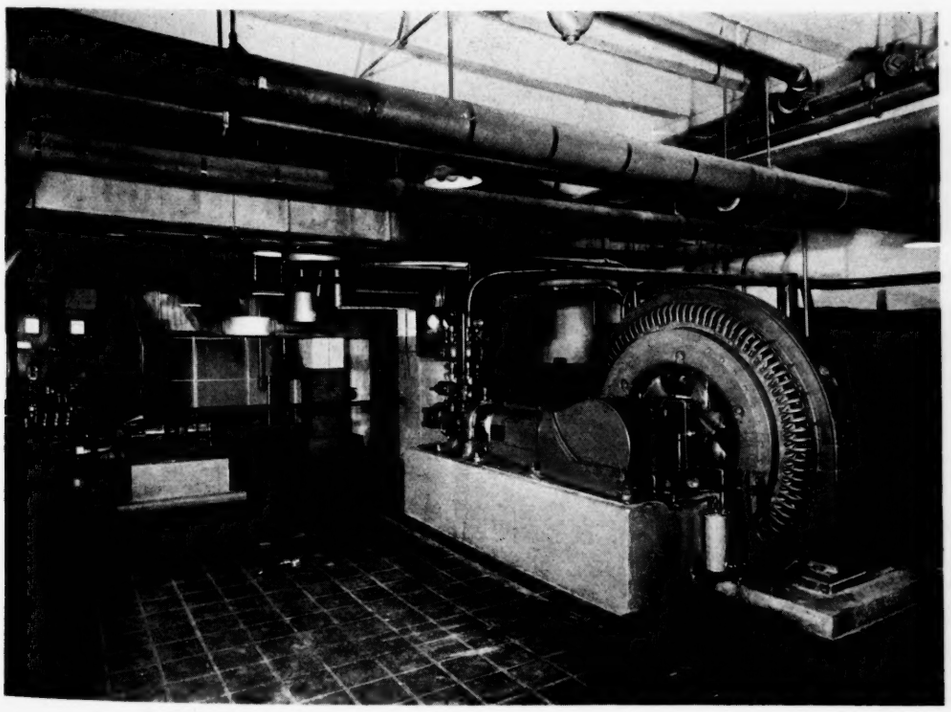
Baudelot coolers are incorporated within each air washer housing and are supplied with refrigerant from a 190-ton carbon dioxide compressor through a direct expansion valve.

One circulating pump is supplied for each air washer. This pump draws the water from the tank at the bottom of the washer and discharges a part of it through the sprays and the remainder over the cooling coils.

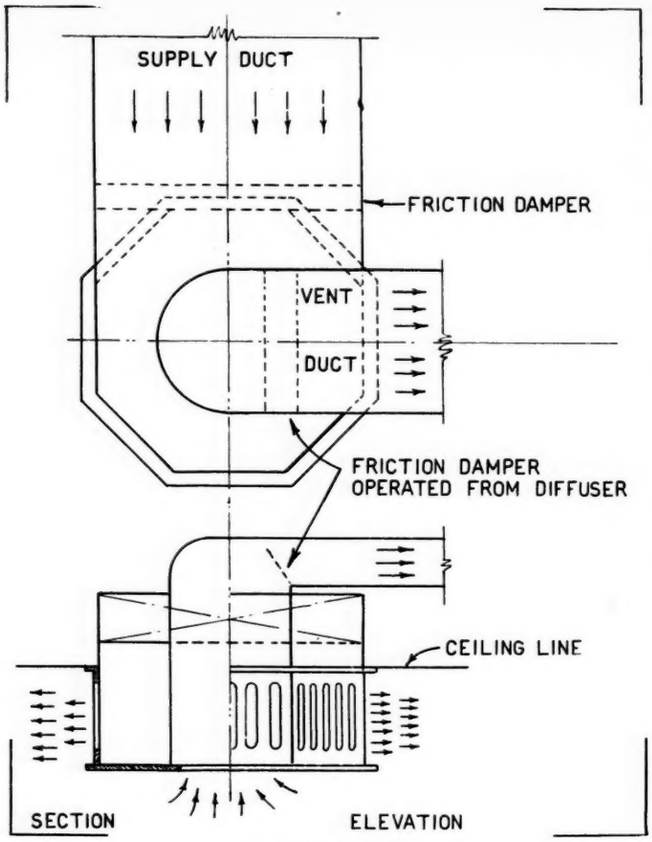
Air washers are set on 4-in. machinery cork bases and are insulated with 1 in. of Celotex in such a manner that no fastening holes are drilled through the washer plates obviating any chance of leaks.

All fans have canvas connections and short Texrope drives. Fans and motors are set on laminated wood bases isolated from the floor with machinery cork.

Underneath the fifth floor, there is a pipe and duct gallery in which the horizontal runs to the various risers are located.

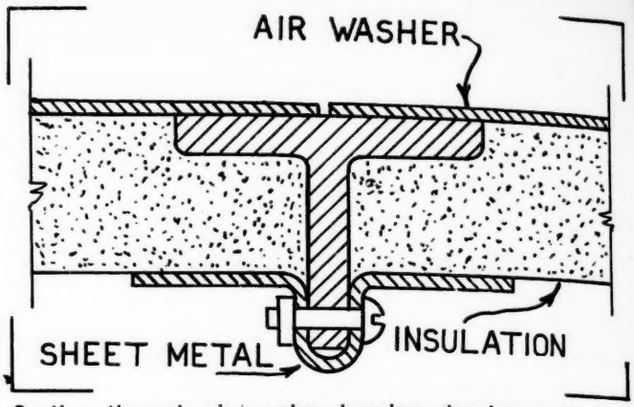


Refrigerating machine showing synchronous motor and exciter set and starting panel.



Detail of outlet.

In the main banking room, the high beamed ceiling with its rich decoration made it possible to introduce fresh air through flat grilles which are barely noticeable from the floor. Vent grilles in this room are located generally behind the bank screen which insures a circulation of air for the benefit of both tellers and customers. In nearly all other portions, however, a ceiling diffuser was developed which in many cases served as both a supply and vent opening.

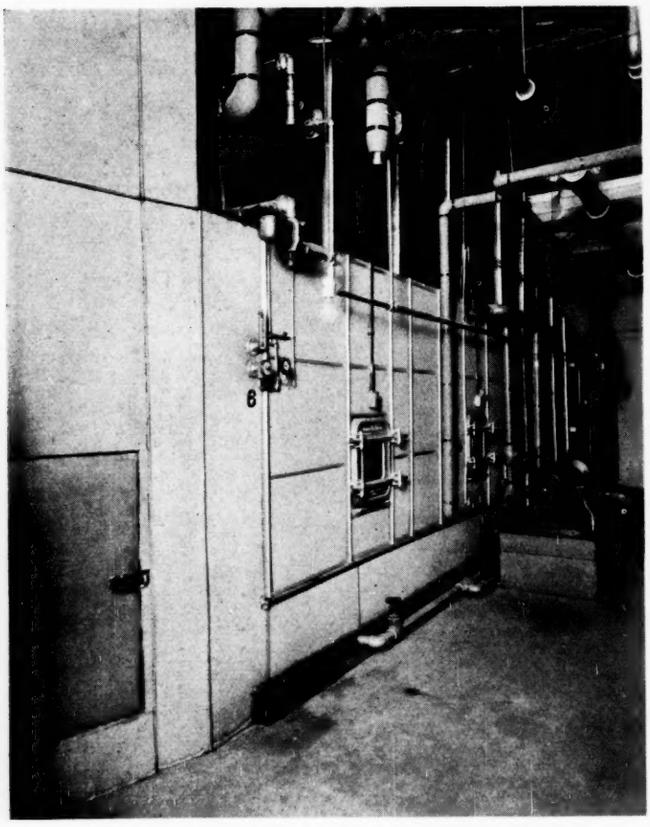


Section through air washer housing showing method of applying insulation.

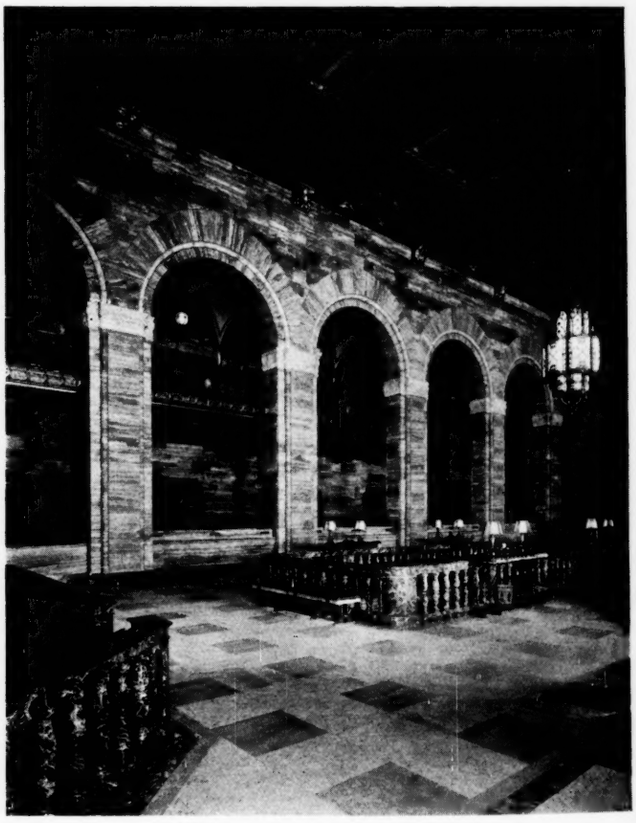
The diffuser was in some cases made of cast aluminum and in other cases of sheet metal. Also, in some cases, the lighting fixtures were hung from the bottom of the diffusers. Air is delivered horizontally with a velocity of approximately 150 ft. per min. from the eight sides. By this means a splendid distribution of air is secured particularly in the long narrow clerical rooms with one row of diffusers through the center.

Mills, Rhines, Bellman & Nordhoff, Inc., Toledo, Ohio, were the architects of this building.

The installation of this equipment was done by The Howard C. Baker Co., Toledo, Ohio, and under the supervision of the mechanical engineering department of Mills, Rhines, Bellman & Nordhoff, Inc., in collaboration with S. R. Lewis, Chicago.



One of the air washers in the Ohio Bank Building.



Main banking room.

Clean Air Necessary for Proper Ventilation of Homes

By FRANK C. TAYLOR†

VENTILATION in the older type of house was practically non-existent. Large rooms with high ceilings were, to say the least, airy. Too, large windows were far from air-tight and allowed plenty of fresh air to leak into the house. The principal problem was to keep the air out by double windows and weather-stripping.

Homes more recently built are of quite different construction because of new architectural design, new building materials, and the need for economy. Consequently, we have insulated houses, small windows, usually weatherstripped, and a finished attic more nearly air-tight than the old one ever was. However, the low ceilings and small rooms, together with the air-tight construction, give inadequate ventilation.

Smoke Pollution Increasing

Residential districts have become more densely populated and as a natural result the air in winter contains more coal smoke from the additional residences than before which, added to the smoke from an increased number of factories, has given us an atmosphere in even the best residential districts full of fine particles of carbon and dirt.

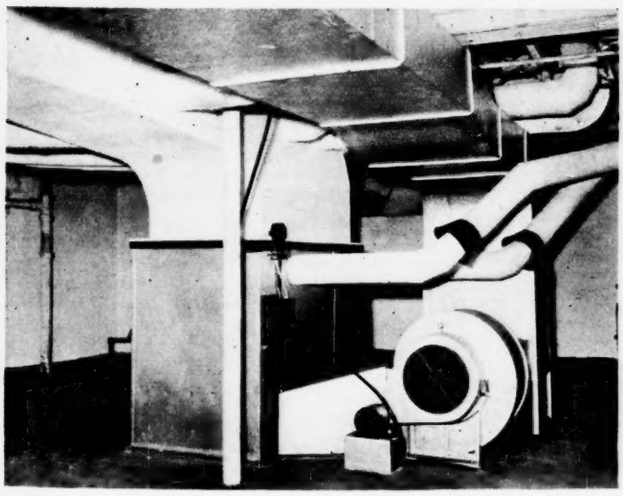
Evidently conditions in the home have changed, but so gradually that the need for ventilation and air filters has not yet been thoroughly realized. Even in summer the low-ceilinged small rooms with small windows are stuffy and are very slow to cool off in the evening.

Just as in the case of office buildings where natural ventilation failed to relieve the situation so that forced ventilation and filters were installed, the home could be made a much more comfortable and healthful place to live in by the installation of forced ventilation.

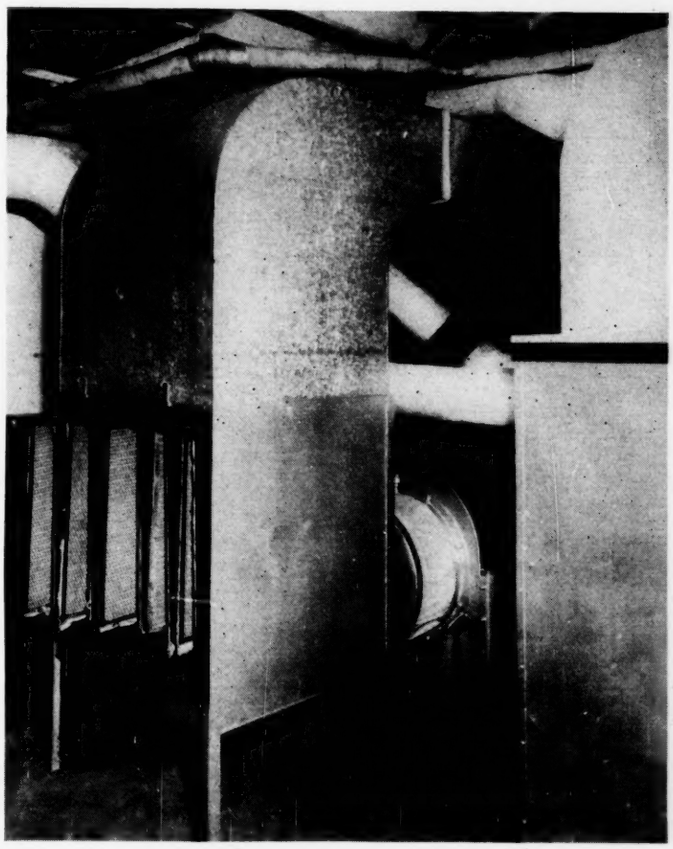
In considering my own home, a small eight-room house, the question came to my mind as to why it would not be advisable to install a fan and filter and use the warm-air ducts for ventilating to supply warm air in the winter and cool air in the summer. Consequently, in the fall of 1928 I had begun experiments with a small fan and paper filter. The results were so good that the following year I installed a fan running at 550 r.p.m., driven by a 1/6 h.p. condenser-type motor through a V-groove belt. The fan, which has a capacity of approximately 800 cu. ft. per min., delivers air into the return duct of the furnace and draws air through the filter, through which air may be recirculated through the house or drawn from outdoors by means of arrangement of dampers.

I found that it was easier to heat the house in winter since the forced air system remedied the situation of insufficient duct capacity for natural circulation. The house was much cooler in summer; in fact, it was possible to be perfectly comfortable in the living room on a hot summer's evening even though all the windows

†Assistant Manager, Industrial Sales Department, Rochester Gas and Electric Corporation.



A modern gas-fired warm-air furnace.



A warm-air furnace showing filters.

were closed. It was also very noticeable that there was less dirt in the air in the house which was proved by inspection of the filter after a month's operation.

The filter I used had an area of 16 sq. ft. and became filled with dust and carbon in about six weeks which indicated that it would be advisable to use a larger filter to increase the time between repapering.

For about two years I have operated this ventilating system in my home which continuously cleans the air and removes the fine air-borne particles of dust and carbon mixed with germs and microbes. As a result of this experiment I have sold myself the idea that clean air in the home is worthwhile.

Ventilation of the home has been held back by the lack of suitable equipment. Motors and fans were noisy and filters were not readily adaptable to home use, but at the present time such equipment is available. Now, quiet-running motors and fans are available, which in conjunction with the V-groove belt, have solved the problem of too much noise.

Setting Heights for Stoker-Fired Boilers‡

WHERE heating boilers are to be stoker-fired one of the most essential details of the layout is the provision of adequate furnace volume. In the many years during which stokers have been used it has been found that there is a rather definite relation between the furnace volume and the heat release if good combustion conditions are to be maintained. The limit of heat release is generally set at 50,000 B.t.u. per hr. per cu. ft. of combustion space to insure smokelessness. This is often taken as the limit in setting up recommendations of the heights of boiler settings and is used in the table recently issued by the Midwest Stoker Association and reprinted herewith.

The table is intended as a guide for architects and engineers, and it will be noted that the boilers included cover the range of sizes that are often used in medium to fairly large-sized buildings.

The term "actual load" as used in the table represents the load really connected rather than the manufacturer's rating of the boiler, but should be used with care. Thus, if a small boiler is installed with the intention of forcing it at the peak loads, the actual heat necessary at the peak should be used to proportion the setting. If an oversized boiler is installed, however, it is not recommended that the combustion volume be reduced to agree with the connected load.

Use of the dimensions as given in the table will result in settings that will agree with smoke inspection requirements in most instances, and provide sufficient space to permit the installation of most standard stokers. The dimensions are not rigidly correct, however, for the particular coal being used is always a factor in the layout. The dimensions of the table are believed to provide for adequate volume for burning the high-volatile coals.

‡ Based on the paper *Recommended Setting Heights for Heating Boilers Equipped with Mechanical Stokers,* presented by E. L. Beckwith, before the Second Midwest Bituminous Coal Conference, May 21-22.

FIREBOX BOILERS

Actual Load	2500	5000	7500	10000	12500	15000	20000	25000	30000
A	18″	18″	20″	20″	22″	22″	24″	24″	24″
B	42″	48″	54″	60″	66″	72″	78″	84″	84″

A=Distance from bottom of Water Leg to floor. B=Distance from Crown Sheet to bottom of Water Leg

COMPACT WELDED BOILERS

Actual Load	2500	5000	7500	10000	12500	15000	20000	25000	30000
A	18″	18″	20″	20″	22″	22″	24″	24″	24″
B	30″	33″	36″	42″	45″	48″	54″	60″	60″

A=Distance from bottom of Water Leg to floor. B=Distance from Crown Sheet to bottom of Water Leg

H. R. T. BOILERS

H. P.	50	75	100	125	150	175	200	225	250	275	300
A	5′-0″	5′-6″	6′-0″	6′-6″	7′-0″	7′-0″	7′-6″	8′-0″	8′-6″	9′-0″	9′-0″

A=Distance from bottom of shell to floor. H. P.=Installed horsepower.

Chart prepared by Midwest Stoker Association

In the case of the firebox or compact welded type boilers the desired setting height can be obtained by combining the A and B dimensions. The load ratings shown for this class of boilers are actual developed loads in square feet of equivalent cast iron steam radiation and are not manufacturer's rating.
The setting heights given for H. R. T. boilers may be used for developed loads up to 50% above normal rating.

Air Conditioning Needs Protection

By MONT H. SMITH, JR.

THE editorial in the February issue of HEATING AND VENTILATING contains food for thought regarding the possible misuse of the term "air conditioning." Any commodity or process popularized and newly offered to the public is usually seized by opportunists, who habitually corrupt its true merit or significance.

Publicity has already heralded the presentation of air conditioning for private dwellings as well as for public buildings and industry. With a multitude of home owners as potential purchasers, it is plainly apparent that the term may be a medium for exploitation of units and installations that are lacking in balance. Attention is directed to the premise that there will be three types of installations.

First. Complete air conditioning, including the utmost attainable, where expense is a secondary consideration.

Second. Modified air conditioning, comprising those features that do not involve prohibitive expense for relatively unimportant factors. For instance, obviously the carbon dioxide factor is unimportant in a private home occupied by a small family and possibly the use of mechanical refrigeration for summer cooling may be an unwarranted expense in certain types of homes in certain localities.

Third. Psuedo air conditioning. It is this latter class that can easily become a blot upon the escutcheon of a modern industry.

Air conditioning is a highly developed science and science is knowledge reduced to law and embodied in system. The man who utilizes thought, skill and constructive power can eventually acquire a vast fund of knowledge of this science, in fact sufficient to engineer certain air conditioning installations.

The following factors will militate against precision in many installations.

First. The speculative builder. It is a notorious fact that he is interested in beating down the price and that he blandly turns a deaf ear to efficiency.

Second. A sycophantic class of contractors, counterparts of the quack doctor.

Third. A certain class of architects who have never displayed sufficient ability to prepare comprehensive specifications for mere heating.

Fourth. Certain jobbers who are essentially scalpers. Their reputation is justly earned through traffic in boilers, radiation and furnaces.

Lip service for national propaganda as to what actually constitutes air conditioning will not suffice. Had certified heating been systematically presented to the public years ago, there would have been less tolerance of fraudulent ratings, a 2-20-200 rule of thumb and the shopworn platitude "guarantee" in the field of steam, hot water and vapor vacuum heating. Had the standard furnace code been as familiar to an unsuspecting public as "save the surface and you save all" there would have been few engineering atrocities in the field of warm-air heating.

It is feared that at the present time there are parasite salesmen, *i. e.*, men utterly lacking in technical knowledge of thermodynamics and aerology who are being importuned to peddle retail or wholesale various units and even installations of the newer trend.

A little bit of knowledge is a dangerous thing. The man who lulls the contractor into a false sense of security is more to be feared than the one who frankly states that acquiring knowledge of the science of air conditioning requires intelligence, a sense of proportion and an intensive study of the mathematics, mechanics, physics and chemistry that apply to air conditioning if proficiency is to be attained.

Is it not a fact that instead of talking in generalities, well directed publicity concerning the approximate minimum requirements of coordinated knowledge of the subject will eventually benefit all concerned?

Before any man can intelligently discuss air conditioning, to say nothing of engineering—a skillful application of the process, he must accurately interpret the reciprocal relationships that exist in the following subjects which are herewith quoted without any attempt at engineering accuracy of designation:

1. The synthetic air chart test which enables the engineer to know the air condition with which he contends, and the air condition that can be attained. A complete study of the air chart has many ramifications.

2. The various classes of equipment suggested for attaining specified synthetic air chart percentages.

3. Heat conductivity of various building materials and the factors to be used to compute the actual B.t.u. losses per hour per square foot of surface per degree Fahrenheit difference in temperature.

4. The number of air changes to be provided for under varying conditions.

5. Humidity—Its measurement and control when an adequate device is provided. The difference between automatic supply and automatic control. The difference between dew point and saturation point.

6. Dehumidifying processes.

7. Air filtration—A knowledge of dry type filters and viscous type filters, methods of determining dust counts, and filter cleaning.

8. Air washers—Their resistances and efficiencies.

9. Bacteria—Relation of bacteria colonies to dust count; development of culture plates.

10. Carbon dioxide—The analysis of samples.

11. Odor determinations and odorometer tests.

12. Air distribution—The location of inlets and outlets to produce efficient air distribution. The observance of air behavior by use of the A C machine.

13. Caloric value of fuels—including bituminous coal, anthracite coal, oils of various grades, manufactured gas, natural gas.

14. Degree day factors.
15. Industrial degree day factors.
16. Computation of net efficiency of heating units:—Dependence upon ratio of heating surface to grate area, the combustion rate and calorific value of fuel in coal-fired units. Dependence upon ratio of heating surface to B.t.u. input in gas-fired units.
17. Centrifugal fan characteristics.
18. Pressure and horsepower required to compensate for friction of air.
19. Dynamic or total pressure which is the sum of static pressure and velocity pressure.
20. The measurement of total pressure and the measurement of static pressure.
21. The computation of foot pounds.
22. The properties of dry air, its weight at varying temperatures.
23. The expansion of air at varying temperatures.
24. The computation of B.t.u. input per cubic foot of air.
25. Electrical and mechanical equivalents.
26. An understanding of the difference between radiation, conduction and convection.
27. The computation of air infiltration and B.t.u. losses through crackage.
28. Windage—Its relation to losses by infiltration.
29. The computation of conduit sizes to coordinate air volume and air velocity.
30. The cooling effect of air circulation without actual temperature change.
31. Mechanical refrigeration for summer cooling.
32. The effect of solar radiation.
33. The comfort chart and comfort zone.
34. Factors to be considered in remote control of temperature.
35. The average volume composition of air.
36. Climatic conditions compiled from United States Weather Bureau reports.
37. Tables of relative humidity, dew points and grains of moisture per cubic foot.
38. Familiarity with the various aerological test instruments.

Setting the Thermostat Back at Night

IN ORDER to get an idea as to the savings possible by setting the thermostat back to a low temperature, the writer collected the data plotted on the accompanying chart.

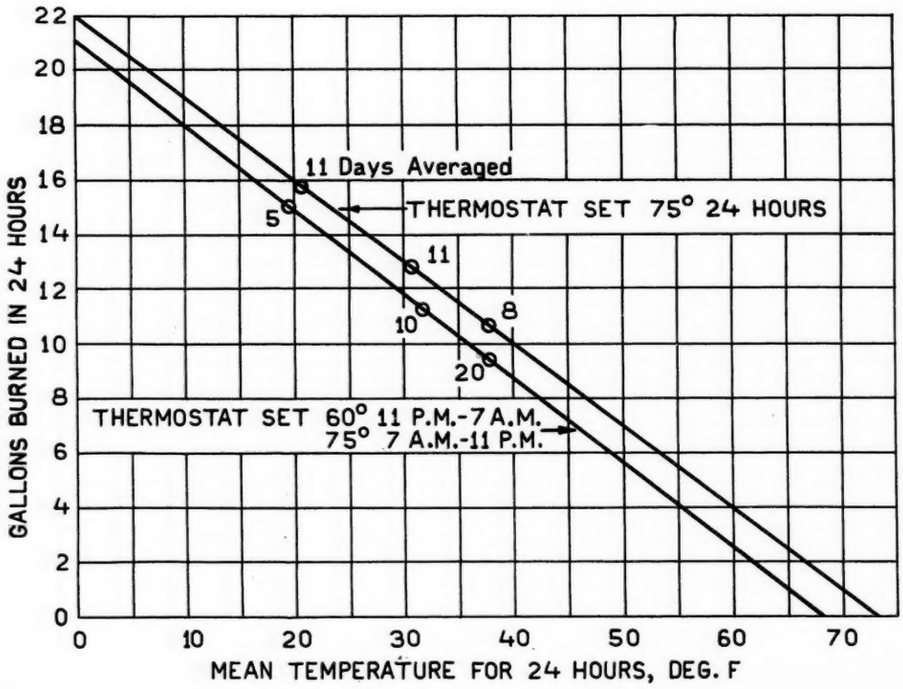
During January, February and March, 1931, a record was kept of the running time of an oil burner each day. The mean outdoor temperature was obtained for each day from the Weather Bureau at Boston. During the period under discussion the oil burner consumed 2.06 gals. of oil per hr. The data were grouped according to temperature in ten degree classes and averaged, giving the following tabulation:

Mean Temperature, Deg.	Oil Consumed per Day, Gallons	Days, Averaged	Remarks
20.8	15.8	11	75°, 24 hrs.
19.6	15.1	5	60° and 75°
30.75	12.8	11	75°
31.6	11.2	10	60° and 75°
38.1	10.8	8	75°
37.8	9.5	20	60° and 75°

These points are plotted on the attached chart and straight lines have been drawn through the two groups.

A study of the chart indicates that approximately 1.1 gal. of oil is saved per day by setting the thermostat back 15° for eight hours during the night.

Data were obtained from an Electrol oil burner burning No. 3 oil. The heating system is hot water with a Red Flash boiler serving approximately 1000 sq. ft. of radiation. The house is two-story half brick and stucco with Celotex lath on exposed walls and under roof, the house being 25 ft. x 45 ft. with two-car heated garage in basement. — *Richard Brown.*



Relation of Fuel Consumption to Outdoor Temperature.

Present Methods of Heating by Thermal Radiations

By T. NAPIER ADLAM†

IN considering the various methods which are already in use, it will be interesting to do so in chronological order, for we shall then be able to see the natural sequence of ideas following each other.

In 1907, Arthur H. Barker of London obtained the first patent for radiant heating. This patent covered his idea for obtaining thermal radiations from plaster in which is embedded a network of pipes. This method was applied to walls and ceilings, although at the beginning it was particularly applied to the baseboard around the room, which was constructed of a suitable plaster to hold the pipes and to allow for expansion.

As this system gradually developed pipes were introduced under portions or all of the side-walls and ceilings to act as heating surfaces instead of using the baseboards.

In the earlier installations the embedded pipes were made of a kind of pewter composition, such as is ordinarily used for composition gas pipes. Recent installations usually use wrought iron, brass, or copper pipes of ½ in. internal diameter. The pipes are arranged in coils parallel to each other at 4 in. to 6 in. apart. (Fig. 6.)

The coils may be placed on the walls or ceilings as desired, with the plaster finished off over the pipes to a thickness of ½ in. to ¾ in. When the coils are to be placed on the ceiling where concrete is to be used, they are placed on the forms, before the concrete is poured. In Fig. 7, the pipes are seen supported close up to the girders, ready for the wood forms to be installed for supporting the concrete. The flat iron bars which hold the pipes together are removed before the concrete is poured. When the forms are removed the lower portion of the pipes will be exposed ready for the plaster, as shown in Fig. 8. If the surface of the concrete is too smooth it is hacked to give a good key to which the plaster can adhere.

Coils may be made in any convenient length up to 200 ft. of pipe, and the ends are connected to vertical pipes which are installed in recesses or chases formed in the walls. Welding is commonly used.

Fig. 5 shows the coils laid on the wood forms ready for the concrete floors to be cast, with one end turned upward and the other downward ready for the connections to be made to complete the circulation. Fig. 4 shows the coils overhead with the circuit risers installed in a recess on the side wall.

Valves are inserted in each riser so that any coil can be regulated independently, or isolated if desired.

When the pipes are embedded in the side walls, they are often constructed with sloping manifold ends to give free access for the air, as shown to the right of Fig. 1, whereas a continuous coil is indicated at the left. The walls are chased to accommodate the pipes, so that the full thickness of plaster is formed over the tops of the pipes.

†Consulting Engineer, Bethlehem, Pa.

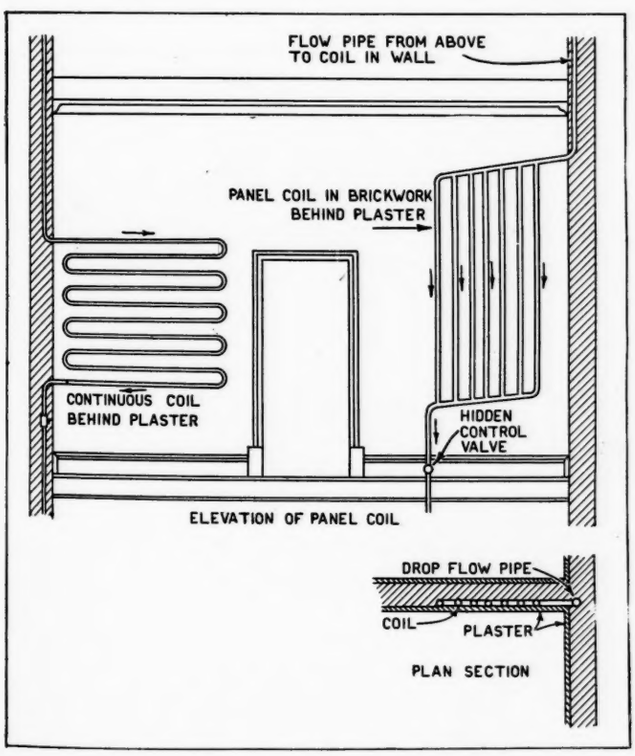
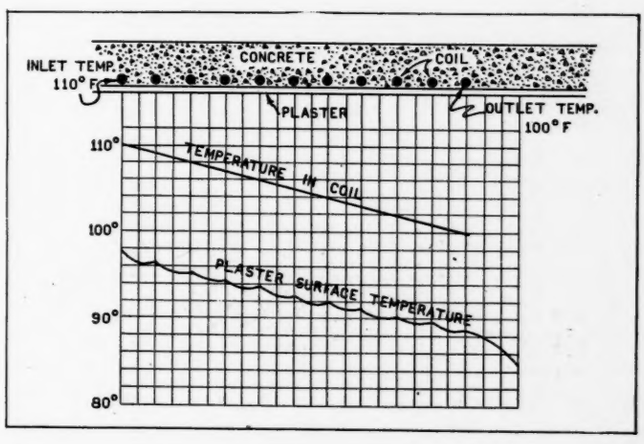


Fig. 1 (Left) In the sidewalls the coils can be either continuous or of the manifold type with sloping manifolds.

Fig. 2 (Below) Water temperature and consequently the ceiling surface temperature falls as it approaches the outlet end.



All the circuit pipes are connected to form a complete system, and the water is circulated around the circuits by the action of a centrifugal pump placed in the basement. The water is usually pumped direct to the top of the building before entering the various circuits, and an air eliminator is installed so that the water is freed of all air before descending to the coils below.

In manufacturing these coils they are subjected to a pressure of 500 lb. per sq. in. before leaving the works, and to a further test of 200 lb. per in. on the site after process. Joints so made have stood the test of time very satisfactorily.

Screwed joints are used only for valves, or where dismantling may be necessary in the future.

Water is usually circulated at temperatures of 95° to 105°, which gives average surface temperatures of about 85° to 95°. In very extreme weather the temperature of the ingoing water can be raised quite safely to a temperature of 130° for short periods.

Calculations for circulation may be made in the usual

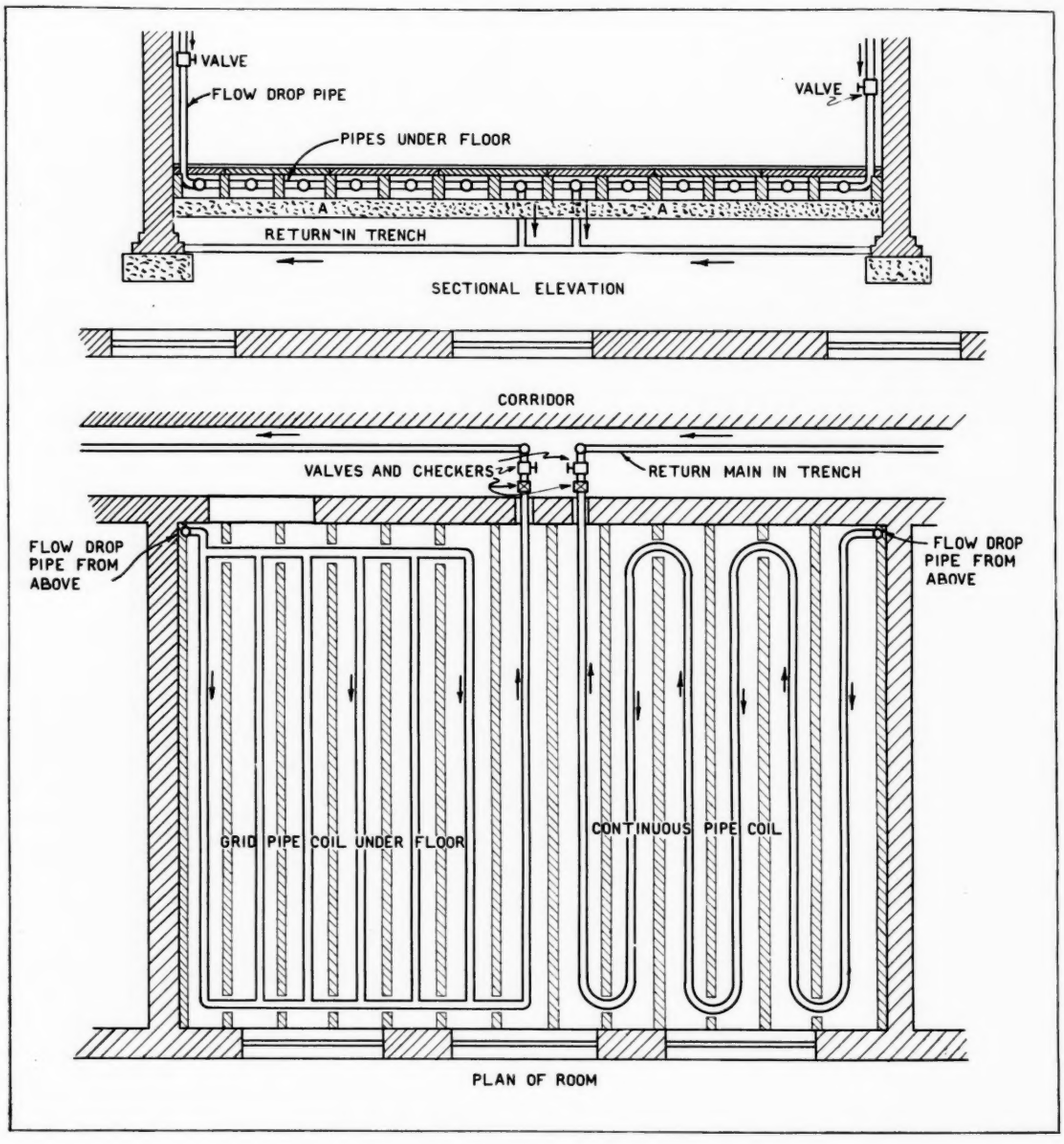


Fig. 3. Plan and elevation of floor heating coils.

the risers, etc., are all connected. In this way every joint is made perfectly tight before the concrete or plaster is cast. This test usually is maintained for at least six hours.

Work on these installations commences earlier than on other systems, and close collaboration is necessary between the heating and floor contractors.

Erectors follow the shuttering gang (the workmen who place the wooden forms for the concrete) after which the welders make the joints. The testers mark each section as they finally pass the work.

Some installations have as many as 40,000 to 50,000 joints, all of which are made by the oxy-acetylene way, but generally 25 to 30 ft. of water frictional resistance on the system is considered good practice. The amount of water passing is generally taken as 3 lb. of water per hr. per sq. ft. of coil surface.

The temperature of the surfaces is not entirely equable over the whole area, as will be seen from Fig. 2, which gives an approximate indication of how the temperature varies over the surface. It will be observed that the temperature falls toward the outlet or return end of the coil.

The patent rights of this system, which is now commonly known as the "panel" system, were purchased from Mr. Barker by Messrs. Richard Critall & Com-

Fig. 4. (Right) Overhead coils with risers installed in recess in side wall.

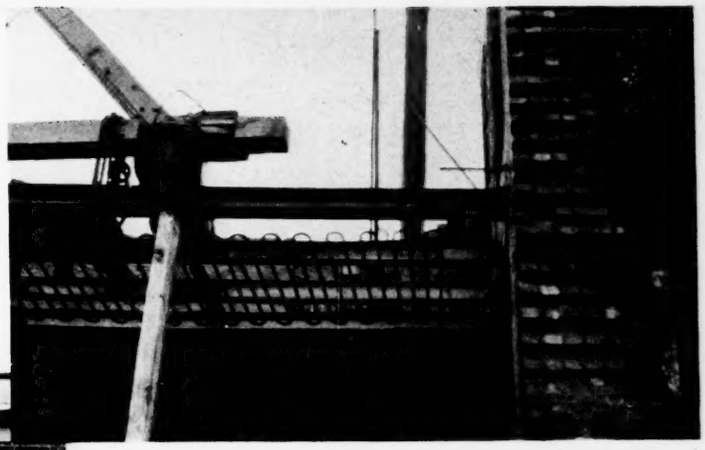


Fig. 5. (Below) Coils laid on wood forms ready for concrete floors to be cast.

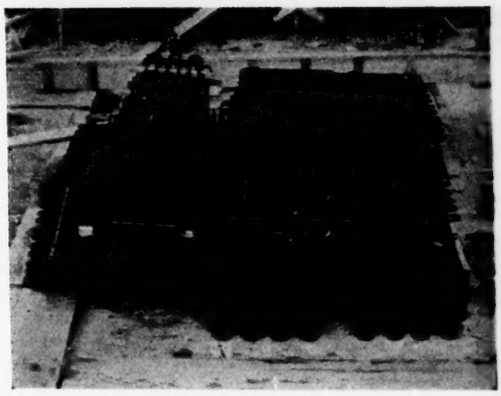
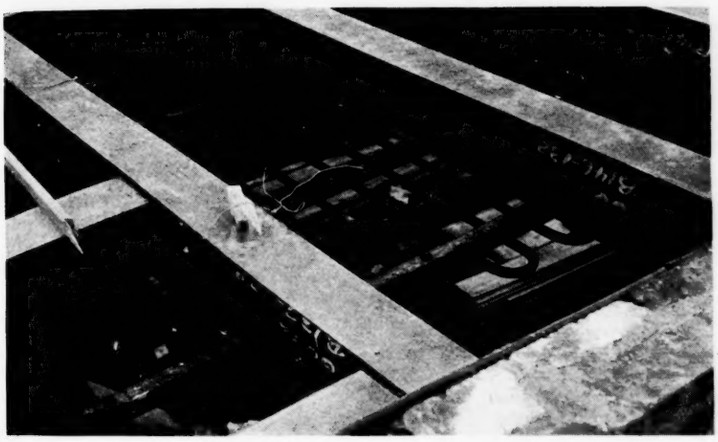


Fig. 6. (Above) Pipe coils ready for installation.

Fig. 7. (Below) Pipes supported close to the girders ready for concrete forms.



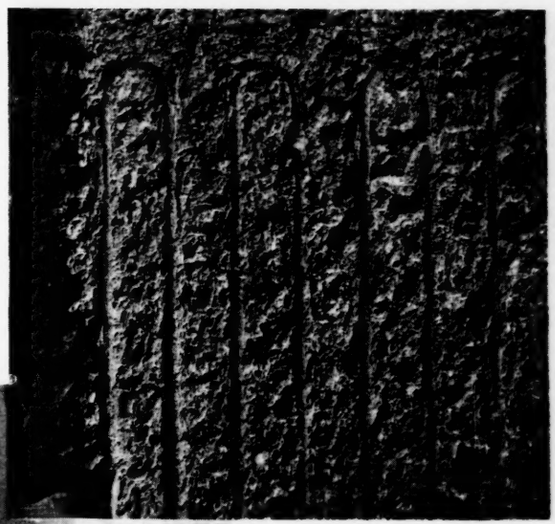


Fig. 8. (Above) Lower portion of pipes exposed after removal of concrete forms.

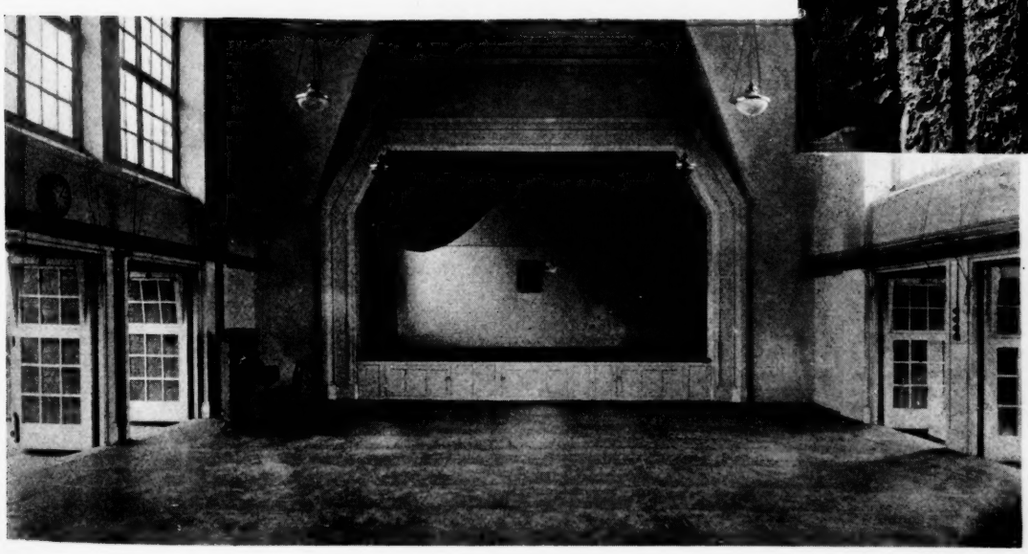


Fig. 9. (Left) A large hall heated by the Widdows' method.

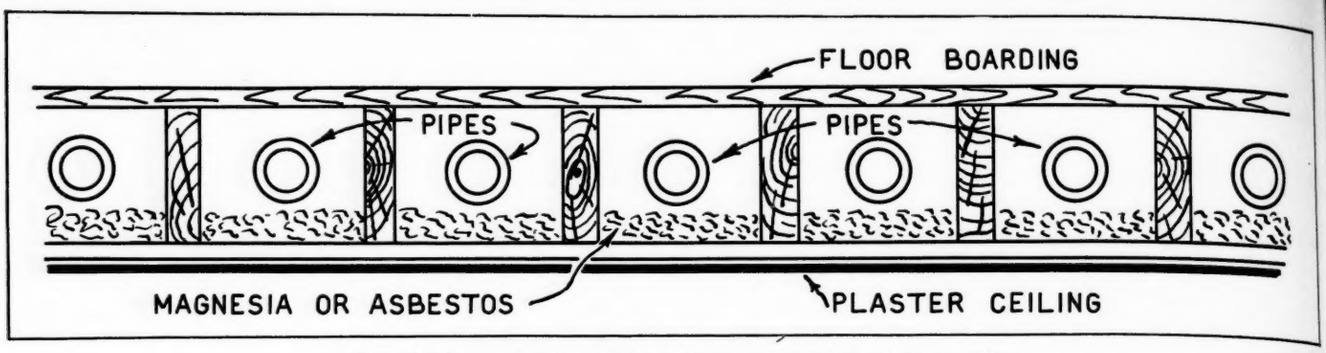


Fig. 10. Cross-section of floor showing location of pipe coils.

pany, of London, who have developed it and installed the system in many of the most modern buildings in Europe.

It has been installed in the British Embassy at Washington, an illustration of which was presented recently in this magazine,[1] and it is being installed in a portion of a house now in the course of erection in New York. Figs. 4 to 8 inclusive are particularly interesting as they are exhibits of work actually done in this country.

Considering the advantages of the "panel" system it is obvious that we obtain the full virtues of radiant heat in a most pleasant form and the outstanding feature is its attractiveness, because it is entirely invisible.

It is absolutely essential that all details of installation be settled at an early date, because the difficulties are great if considerable progress has been made with the building before the heating engineers commence operations.

Several points have been raised against the use of this method of heating. Among them is the fact that since it is entirely hidden it would be almost impossible to trace the pipes if trouble developed in operation and the plans were lost. Development of cracks in the plaster also has been cited as a disadvantage, but as several manufacturers have now produced reliable material, the risk of cracks is not great.

The low temperature at which it is necessary to operate is undoubtedly a disadvantage in some instances. Especially is this true when it is desirable to heat up quickly. Also, when panel heating is used in conjunction with direct radiators the latter become very ineffective.

If the building becomes too hot, it may take a considerable time to cool. Also, where a room is quickly filled with a crowd of people, there is danger of overheating. This, however, is the case with most heating systems within certain limits.

Use of good thermostatic regulation is vital with this method for if by any mischance the temperature rises too high the plaster will crack due to the excessive expansion.

Another disadvantage is the extreme inflexibility, for having once been installed the coils cannot be changed or modified without removing the plaster, and cutting into the concrete. A leak is very troublesome, for it is no small matter to cut away the plaster and concrete in order to get a blow pipe flame all around the pipe, and to make good the decorations. Any choking up or stoppage of the pipes would also lead to difficulty because the location of the stoppage would be so hard to determine. Fortunately operating troubles have been very rare, but the possibilities have to be given due attention.

Another point to be considered is the limit to the height of building adaptable. Steam cannot be used readily with this method owing to its high temperature and the difficulty of draining.

Time lag needs to be considered, for with the mass to heat or cool, the change of temperature effect is slow to respond to the rapid outside changes, unless the structure is such that it will act as a protection against rapid interference. The ideal building for use with this method is one of heavy construction, of medium height, and where comfortable conditions and aesthetic treatment are important considerations.

Although I have so far dealt only with installations where coils are embedded in concrete or brick walls, there are standard methods for accommodating panel pipes in other constructions, such as hollow tile and wood joist floors. In these constructions the plastering can be carried out by any good plasterer with the right material.

Floor Heating

The next development with radiant heating was a system whereby thermal radiations are emitted from the floor. This was introduced in England in 1913 by Geo. H. Widdows, county architect of Derbyshire.

Mr. Widdows introduced the idea of placing pipes below the floor, thereby warming the surface of the floor sufficiently for it to give off the necessary thermal radiations to keep the occupants comfortable.

Steam was first utilized as a heating medium, but realizing that the required heat could be obtained at a much lower surface temperature, the designer changed the heating medium from steam to hot water.

The method of construction will be easily followed by referring to Fig. 3. The pipes under the floor are usually of 2 in. diameter made of wrought iron. They may be constructed as a continuous coil as on the right of plan in Fig. 3 or in grid formation as shown to the left of plan in Fig. 3. These pipes are supported 2 in. above the level of the under-floor of concrete which is about 6 in. thick.

The hot water is usually circulated by gravity as the frictional resistance in these larger pipes is small compared with that in the smaller pipes of the panel system. There is no disadvantage in using a pump for accelerat-

[1] *Panel Heating in the British Embassy*, HEATING AND VENTILATING, May, 1930, page 82; June, 1930, page 77.

ing the circulation, and for large jobs it is certainly an advantage. For small buildings and districts where there is no electric power the possibility of a natural circulation does, however, offer many advantages.

The main flow pipe is usually carried overhead on the side wall or in the roof, so that all air may be eliminated at the highest point as with the panel system.

To make this circulating arrangement clear Fig. 11 shows the principle of how practically every hot water system in England is installed.

An open tank (A) is placed at a high point of the building well above the circulating pipes, and usually in the roof. A cold water supply pipe from the water company's main is connected to the tank with a float valve to control the level. This keeps the apparatus filled with water, so that water is always in the system, even though the company's supply may be shut off. The upper part of the tank gives room for expansion of the water when heated, which takes place through the supply pipe (B). Open air pipes can be placed at any point to air vent the main, providing the pipe is carried above the level of the water in the supply tank (A).

Incidentally, I would like to digress here and add that all domestic hot water supply systems in England are installed in a similar manner, and never connected directly to the water company's main as is common in this country, thereby insuring a supply of water should the company's main be shut off.

Reverting to the heating pipes under the floor, it is common practice to install these pipes 12 in. to 18 in. apart, with a slight fall from the flow connection to the outlet.

If the floor is constructed of concrete, a series of parallel divisional supporting dwarf, or sleeper, walls made of hollow bricks or concrete, are formed between the pipes. On these supporting walls are placed concrete slabs of suitable size and thickness, upon which can be placed any desirable flooring such as wood blocks or wood flooring, providing nothing is added which will become plastic or tacky with the heat.

The upper part of Fig. 3 is a section of a floor taken at ground level. If the soil is directly below the concrete underfloor (A) as shown, then any heat passing downwards gradually sets up a temperature gradient sufficient to resist further transmission of heat, owing to the low conductivity of the earth, but where the floor is constructed with a hollow space below, or the floor situated above the ground level with another room below, then a layer of magnesia or other non-conducting material should be placed under the pipes to prevent the heat passing downward. Often the upper floors are constructed with hollow blocks, the air spaces in the blocks acting as a non-conductor and retarding the transmission of heat downward.

Some users of this floor method of heating fill in the spaces above the pipe with sand, so as to distribute the heat more evenly over the whole area, but this does not appear to be necessary.

Mr. Widdows, who has paid special attention during the last 18 years to the thermal radiation method of heating in schools, has evolved conditions which are worthy of more than passing comment, and we will consider his efforts later when considering the general effect of these systems, and the studied reports of the Health Research Board.

A very suitable flooring construction has been designed by Mr. Widdows which is easily laid and easily removed. Reinforced concrete beams are cast of suitable depth and span to suit any reasonable size room, and the formation of these beams is such that the pipes can rest in the space between each one or alternate ones, and a niche is cut away at each end on which the manifold end pipes rest. The beams are placed in position as the building proceeds, so that it is possible to install the pipes at any stage of the building operations.

The depth of the recesses in the concrete beams is about 7 in. so that there is 3 in. between the top of the pipe to the underside of the covering slabs. These slabs are constructed of concrete 1 in. thick and about 24 in. square. They are strengthened by ribs cast underneath and the edges of the slabs rest midway on the beams. On the top of the concrete is a layer of composition granwood tiles 5/8 in. thick embedded in with cement. The coloring of these granwood tiles gives a very comfortable appearance to the rooms, and with the addi-

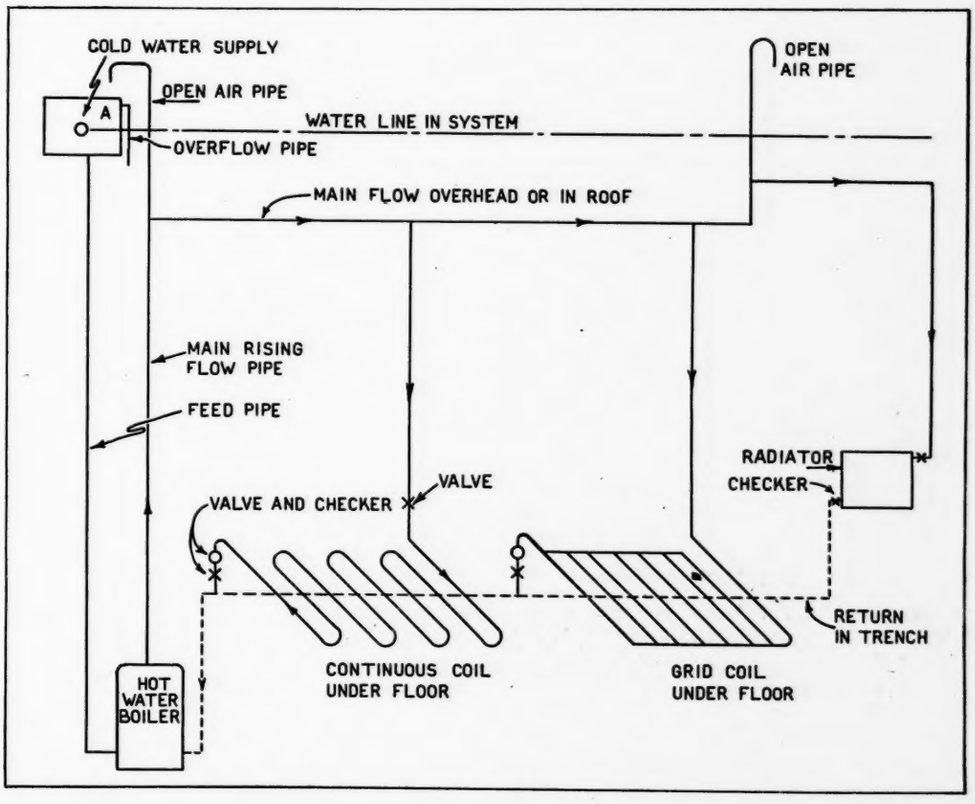


Fig. 11. The general arrangement of the hot water system as installed in England.

tion of rugs or carpets placed on the floor an agreeable condition of comfort is established.

One great advantage with this type of construction is that the whole floor of a room of 400 sq. ft. can be lifted in about 30 min. without any damage whatever. This enables a speedy examination to be made of the pipes at any time, and repairs, if necessary, can be effected with very little trouble.

There are many other methods of flooring which may be adapted, but if the floor covering is not made removable in some convenient way then that portion of the floor above screwed joints must be removable to provide for repairs.

In addition to concrete floors it is quite a simple matter to install the pipes in wood joist floors, with suitable adaptation.

Fig. 9 shows a large hall heated by Mr. Widdows' method. It will be observed that the heating supply pipe 3 in. in diameter is carried along overhead under the high level windows. The pipe acts as a combatant against any down draft of air from these windows. The drop pipes from the overhead main can be seen on the side wall, and each drop pipe is fitted with a valve for regulating the supply of hot water to the coil.

The return pipes from the coils are collected into one common return pipe, which passes back to the boiler in a trench. In the return pipe of each coil is fixed a permanent checker[2], which can be adjusted to give a uniform temperature throughout the building, and then permanently locked.

The temperature of the water conveyed in the pipes varies according to the outside temperature, usually between 110° to 150°, and normally it is found that when the surface temperature of the floor is from 66° to 76° a very comfortable condition is maintained within the range of moderately cold weather.

I found during the extreme weather conditions experienced in this country last winter that steam pipes underfloor proved very suitable, and with the selective vacuum system of steam heating used, which varied the temperature of the steam automatically according to the outside conditions, an ideal arrangement was accomplished.

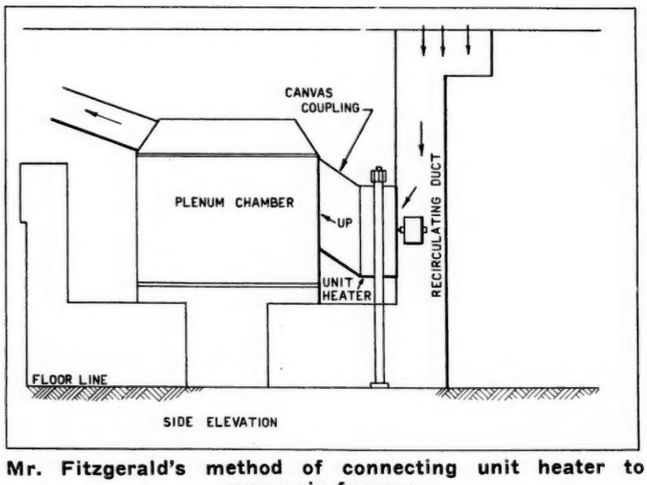
One disadvantage claimed against the floor method of heating, is that people with tender feet may find the warm floor very troublesome. As the surface temperature is much below blood temperature, however, not much inconvenience is felt unless a person stands still on the floor for any length of time. If this is done the surface temperature of the floor under the feet may gradually rise to 110° or 120°. No heat is given off over that portion covered by the feet to keep it cool, which allows it to build up a surface temperature much higher than the exposed portion of the floor.

On the other hand the comfort conditions are ideal, for the effect is similar to the natural outside conditions where the sun warms the earth by direct radiation, while the earth sends back the energy in longer heat waves. These keep our bodies and the air around us warm, making the conditions so pleasant during summer evenings after the sun has ceased to radiate its full energy. We have seen in the earlier articles that the lower strata of air absorb the longer heat waves as they rise from the earth, and thus they keep the lower portion of the air warm. This is exactly what happens with a warm floor, where the thermal radiations are emitted upwards. We find the lower portion warmer than the higher, and consequently our feet and legs are kept warmer than our heads, so that we can sit with our bodies in comfort while we breathe air which can be brought in cool, without disturbing the efficiency of the heating system or its effect upon our bodies.

[2]The checker, as it is called in England, is a tee with an adjustable plug in the side outlet. The plug can be screwed down to increase the friction in the line.

Unit Heater Plenum Chamber Connection

IN the May, 1931, issue of this publication a plan for using district steam to supply an air circulating system was shown in which a unit heater was used as a convector. The unit heater was located in the cold-air duct and the canvas connection to the plenum chamber, which was essentially the jacket of the warm-air furnace, led downward.



Mr. Fitzgerald's method of connecting unit heater to warm-air furnace.

Robert L. Fitzgerald, of the Indianapolis Power and Light Company, states that his company's experience with this method indicates that the connection should lead *upward* from the unit heater to the plenum chamber and not *downward*.

The principle involved is that "The passage of warm air should be continuously upward or horizontal, never in a downward direction." In proof that his contention is correct Mr. Fitzgerald writes that with the downward connection when the thermostat operates to shut the fan off, the flow of air through the heating unit is reversed and the cold-air recirculating duct becomes a warm-air discharge. In the event that air filters are put into such a duct the warm air in reversing flow has a tendency to carry oil fumes from the filter up the cold air duct to the house and which may become very objectionable. Mr. Fitzgerald recommends the use of a plan as shown in the accompanying sketch rather than as shown in the May issue.

Fundamental Aspects of the Natural Gas Situation in Chicago‡

By SAMUEL INSULL, JR. †

No development in Chicago has raised so much speculation in recent years as the advent of natural gas, brought there through a pipe line nearly a thousand miles in length. Its use brings new problems both economic and technical, all of them clouded with much uncertainty. Here is a brief resume of the basic economics which should quiet the fears of those alarmists who see the doom of other fuel industries. Contrary to general opinion only those domestic consumers using large amounts of gas, such as for house-heating, will benefit greatly.

THE TIME has pretty well passed when we can look at one industry alone. Particularly in periods of recession, if not depression, we come to realize forcibly that we cannot consider one industry without considering the others affected by it. In an approach to any problem such as that of natural gas we must consider it not as an isolated phenomenon, but as one aspect of the fuel problem as a whole. I would try, insofar as I can, to deal only with certain fundamental considerations which, though they may be controversial in the construction which can be put upon them, are fairly well established in an isolated existence as facts.

One trouble with the United States is that it has too much fuel. Let me illustrate. Three years ago I came to have some contact with the Illinois coal industry. I became convinced of the obvious fact that at that time if any Illinois coal company could average $2.25 in the cars for its mine run, it would probably be earning all the charges that it ought to set up on its books.

All of the Illinois coal industry, with certain notable exceptions, was then just barely getting along.

Now, at the same time, it was my good fortune to spend about two days in Essen, where I enjoyed a pretty close view of the German coal industry, which at that time was on a satisfactory basis. It was earning its senior interest, a fair depreciation and was paying dividends on its stock, in the face of the fact that the cost of handling coal in cars at the mine head was $3.75 a ton; $3.75 a ton in Germany and the industry on a profitable basis; $2.75 here and the industry on an unprofitable basis.

Why that disparity in the face of a cost situation seemingly favorable to America? Just this, that the coal industry in Germany was based on a limited supply surrounded by a satisfactory market, whereas in this country there was a satisfactory market surrounded by an unlimited or almost unlimited supply.

Now, therefore, if it had not been for technical improvements in the art of transmission line building, and the discovery of natural gas not only in unforeseen quantities, but in unforeseen quantities per unit of production, natural gas would never have been much of a prospect for Chicago since the exhaustion of what we might, in the national sense, term fields local to Chicago.

From that point of view of the balance of supply and demand, there was no necessity for the bringing of natural gas into Chicago. On the other hand, the discovery of the resource natural gas in quantities heretofore unsuspected and in unit production of sufficient size to bring production cost down materially—those two facts, coupled with improvement in the art of transmission, alone made natural gas a prospect for Chicago.

You might ask why natural gas, therefore, was brought here at all. This, I think, is the reason. The gas was in Texas. It could be gotten out at a reasonable price. Producers were bleeding it and wasting it into the air, and manifestly, being furnished with the means of conducting it to a market, thither it was going to be conducted somehow. So that we have this paradoxical situation where we are bringing more fuel into a market, which from the point of view of the fuel industry, is suffering from an over-production.

In the good old days if an industry were in trouble and had to dump its goods, that was a matter of congratulation on the part of those altruistic gentlemen who bought the goods. They just squeezed the fellow as long as they could and as hard as they could and got the lowest price.

Now, I am not implying, and I hope to correct any impression in that direction, that the advent of natural gas into Chicago is going to wreck or even seriously damage other fuel businesses. But we must recognize that the time is past when we can sit back and say, "Here is something that is going to beat the price of fuel down. Isn't that lovely?" We have seen on so many sides, and the matter is not only one of general remark but one of specific recognition, that if any industry in a community is seriously out of joint the whole community will be adversely affected. Somehow the infection will spread.

No doubt some of you thought I would be rash enough to tell you just what natural gas would be sold for in Chicago. As I have said, I don't know; although I would say it cautiously, I don't think anybody knows including all the people who think they know. I don't think anybody can afford to "go short" on a thousand miles of pipe line construction.

That is what an attempt to say now what natural gas landed in Chicago would cost would amount to, and, of course, it will have to be sold for pretty near the cost, allowing for the earning of the proper fixed

‡ Extracted from a paper presented before the Western Society of Engineers, January 19, 1931.

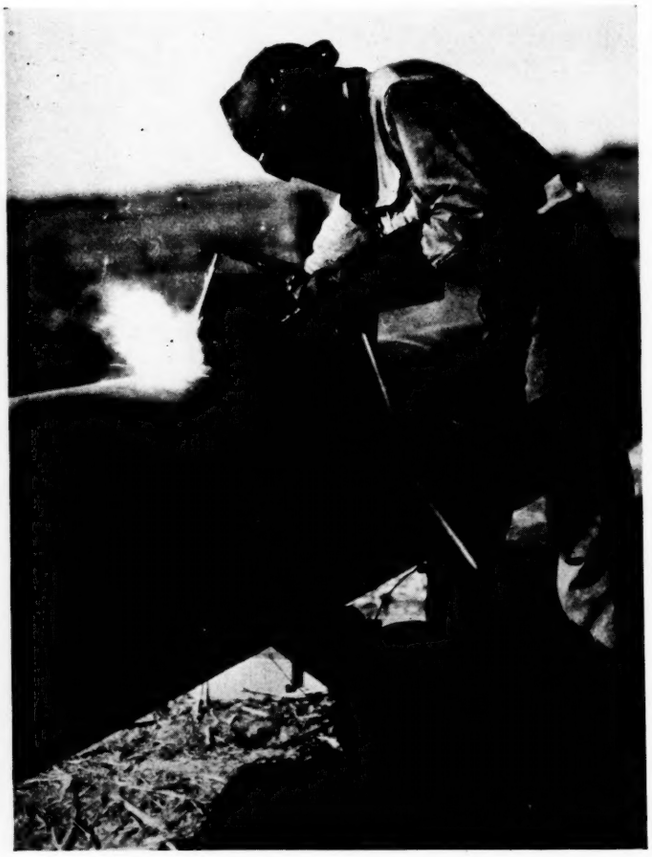
† President, Midland United Company, Chicago.

charges. So I am going, if you want to accuse me of it, to dodge the whole question. I don't regard it as dodging it. I regard it as having the frankness to face the fact that we don't know exactly what this figure is going to be.

We know certain things, however. First, that natural gas is going to cost three to four times as much to get to Chicago as those prices which we have known in the past as normal field prices for natural gas. That is an involved statement, but let me explain why I make it that way. We can't quite say what it is going to cost to produce gas under these new conditions.

First, there is the question of load factor, which is a new one. Second, we are in some untried territory so that we can't talk in terms of the field cost. But if—and I doubt they will be—the field costs were to be the same as they had been in the past, we would know that it would cost at least three to four times as much to transport gas from Texas to Chicago as the old cost of production in the field.

The second thing we know is that practically all those transportation costs are per annum, whether they are interest and depreciation, which are properly called fixed charges, or operation. Attendance and maintenance will both be practically fixed. So that this whole cost is vastly larger per annum than any cost of which we have thought in connection with natural gas before. In reducing this annual cost to a cost per thousand cubic feet, we will be faced with the importance of the load factor, with a computation of the effect of that load factor or rate of average use upon the cost, which we have never been faced with before in the gas business, nor, to my knowledge, in any other.



Welding a 20 in. natural gas pipe line 100 miles long.

You hear more about the load factor in the electrical business than anywhere else, but even in the electrical business a company whose fixed expenses are equal to all its other expenses is going pretty high, whereas here we have a business whose fixed expenses are likely to equal 80 per cent of its total outgo.

What is going to be the effect? In the first place, natural gas is not going to be God's free gift to man when it gets to Chicago. The sooner we face that situation the better. Manifestly, the investment in the pipe line will have to earn its fair return. That is to say, the fixed charges on it and a retirement of the pipe line over a reasonable period of time, the period being, as near as we can guess it, the life of the field. The existing facilities already installed will also have to continue to earn their fair return, and I am perfectly willing to admit that from there on the public is the residuary beneficiary of the whole transaction. That is to say, after the new investment used for bringing the natural gas to Chicago has earned its fair return, after the existing investment has earned its fair return, the public will get what is left, after the producer has been paid for the product.

There are, if you please, four parties at direct interest in this transaction. Previous remarks cover two of them and a part of the third. First, the pipe line, which will get its reasonable charges, and you must recognize in figuring those reasonable charges that the investment in that pipe line is subject to a good many risks and will have to be retired over a pretty short period.

Secondly, the existing companies will get their fair return, but no more.

Third, is the question of the public, which must be subdivided for the purpose of this consideration.

Fourth, is the question of the producer. Lastly, there is a party with a collateral interest, namely, the other fuel suppliers.

The third group enumerated the public, which I would like to divide again into four classes.

First, the domestic consumer of gas other than house-heating will not get much benefit out of this situation. I think anybody with any touch with the gas business, whether from the outside or the inside, is pretty well convinced that the small domestic consumer just about pays his way, and in most cases barely so; the reason being, of course, that the actual gas he uses is a very small part of the cost of serving him. You have the reading of the meters, the maintenance of the mains, and so on, which again go on at so much per year. So that, even if natural gas were to be greatly reduced in price, you would only be affecting in the total about 20 per cent to 25 per cent of the items which go to make up the cost of serving the domestic consumer, and, therefore, any saving that comes from natural gas, great or little, will only affect the domestic consumer to the extent of one-fifth or one-quarter in the saving of the gas itself.

Now, as to the second part of the public. I have already tried to indicate to you that when it comes to the industrial market, natural gas will have to meet some pretty stiff competition.

It is perfectly obvious that if natural gas goes into industry it is going to encounter price competition. Natural gas is going to get some of the business, and I think that it is going to get largely those businesses where a solid fuel has a physical drawback. I would tell you quite frankly that, with a large, efficient boiler plant, gas at the lowest figure that has been guessed at can't be landed in Chicago for less than twice its worth to be burned under those boilers—that is, with a large efficient boiler.

Of course, the ratio goes all the way down to the small very inefficient boiler, where gas can be landed here probably for considerably less than it is worth for the greater ease of burning a gaseous fuel. But that one fact gives us a pause. It is an additional base upon which to stand our judgment that natural gas for straight boiler operation is going to have pretty hard going. Most boilers are pretty efficient nowadays and in the efficient boiler the solid fuel has not the relative disadvantage that it has in the inefficient boiler, so that I think you can sum it up by saying that from the point of view of the industrial consumer he is not going to get much price benefit out of natural gas. Where solid fuel is an impediment to him, he is going to get for nothing probably the advantage of swinging over to a gaseous fuel. Or he is going to get it for a price in the form of increased cost of fuel, which is low in comparison to the advantage.

House-Heating Customers to Benefit

Now, there is a third group of the public, namely, the potential user of house-heating. He will, I believe, be the principal beneficiary of all the people I have mentioned so far and for this reason, as all of us know, the householder has not an unlimited source of capital. If you go to a corporation which is in good financial condition you can generally sell it on anything where the economy more than equals the interest and write-off on the means of using the new product. But with the householder that is not so, because he must earn back any capital expenditures he makes very quickly. That is to say, the private householder can't go back to the treasurer's office and get the price of a gas conversion or a gas boiler by signing a voucher.

If, therefore, gas house-heating is to appeal to the householder by some means it is going to have to earn him back his capital investment very quickly. From his point of view, after two or three years of paying himself back, he is going to have the benefit of gas house-heating for a considerably less amount than the normal premium.

Now, you might say, why this anxiety about the householder and domestic heating? It is simply this: the domestic heating game is the small boiler game. Compared to the big industrial boilers, small boilers are less efficient for solid fuel. With the bigger boilers gas has a hard time to fight solid fuel. By a process of elimination it must go principally for the domestic fuel market, if that market were not in definite prospect the new pipe line could never be built.

So that, with those three people in the inverse order, the householder, the industrial consumer and the domestic consumer other than house-heating we have dealt with the public, and that leaves us the other fuel people.

All Competing Fuels Will Not Suffer

Now, a great deal of the fuel that comes into Chicago, both coal and oil, comes in for a specific reason. Oil is needed for some particular process. A certain kind of coal is needed for a metallurgical process, and so on. We must remember that none of those processes will be affected by natural gas at all. In considering the effect of natural gas, we must recognize that the rest of the fuel industry not only has a right to live, but is in just as good a position to put up stiff competition as gas is. The rest of the fuel industry is probably going to lose certain domestic business and it is probably going to lose certain business where a solid fuel is an impediment, a classification into which, from a certain point of view, the domestic business comes, because of the consideration of efficiency. But outside of that, the rest of the fuel business is not going to be demoralized, although it will undoubtedly be affected by natural gas.

Considering the natural gas situation, therefore, as a part of the fuel problem as a whole, we come down to this situation at the present time, that the natural gas pipe line will earn a fair return, the same kind of return that capital put into other industries having the same financial characteristics would earn, no more and we hope no less; that the existing distribution companies will earn upon their existing facilities about what they are now earning; that the public must be considered under three separate heads, first, the purely domestic consumer, who because gas itself is so small a portion of what he pays for, will not benefit much; the industrial consumer, who will probably not benefit much except in operations where a solid fuel is an impediment, and he must now pay a big premium to avoid a solid fuel. He will secure a non-solid fuel without the proportionate premium. Thirdly, the householder who because he is so necessary to this picture, who because his equipment falls into the class of service that natural gas can appeal to, and because of his own financial problem, which you must solve in advance if you are to secure him, the domestic householder will benefit.

You come to one other class whose position is obvious. The producer in the field will benefit because he will be selling something that he is now throwing away, and in the final analysis you come up against the rest of the fuel industry. The medicine is never as bad as it is supposed to be. Competing fuel business will undoubtedly be affected, but in no disastrous or fundamentally serious degree.

We, therefore, come to the conclusion that natural gas is not yet one of God's free gifts to man, that you have got to pay those people for putting the covering on the pipe, and you have got to pay a host of other people, and the money has to come from somewhere. To sum it all up, there are a great many people who will be no worse off than they were before as a result of natural gas, but there are only two classes who will be distinctly benefited, namely, the producer in the field and the consumer of domestic house-heating, with a kind of secondary benefit to the user of fuel in process work where solid fuel is a detriment.

Air conditioning system in printing plant.

Air Conditioning

Part XI—Apparatus

By WILLIAM HULL STANGLE

NOW that data have been presented from which desirable combinations of temperature and humidity can be obtained for securing comfortable living conditions during either summer or winter, and since it is possible to determine the quantities of heat involved from psychrometric charts, all necessary data are available for determining the quantities of heat and air required at various parts of the system. In other words, the basic and essential information has now been presented.

Since outside conditions are different in the winter from those in the summer, different inside conditions prevail, involving air cooling or air warming, humidifying the air at some times, and dehumidifying at others, the actual apparatus for accomplishing the desired results must necessarily be very carefully designed and proportioned. Moreover, it must be capable of being carefully balanced and must be so arranged that it can be operated effectively if it is to accomplish the intended results. Where possible, it is usually desirable to incorporate automatic control of the operation.

A number of means of accomplishing the conditioning of the air have been and are now in use, among them being the plan shown diagrammatically in Fig. 2. It will be noted that in this method air is drawn in from the outside and is mixed with air recirculated from the conditioned space; that part of the air is caused to pass through a liquid spray, then through eliminator plates and through the fan to ducts for distribution to the points required. The figure as drawn and labeled shows the apparatus as it would be operated during the warm season. In order to function during cold weather, the operation would have to be changed somewhat but the actual apparatus remains the same. Instead of having a refrigerated water supply available, a heated water supply would be substituted. Also, instead of drawing the outside air directly from outdoors to the mixing chamber it would pass over air preheaters. Fig. 2 is strictly diagrammatic and does not involve all the details of the construction.

Let us now proceed to a consideration of some of the items of apparatus somewhat more in detail. It is not the intention to discuss either all the items of the apparatus for the method shown in Fig. 2 or to discuss all possible plans, but rather to discuss, item by item, cer-

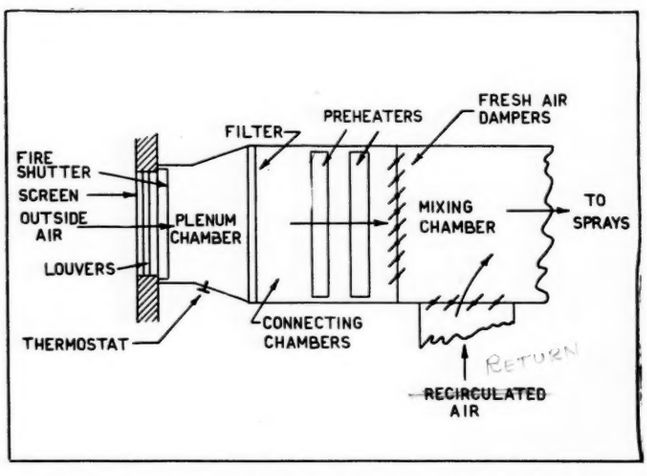


Fig. 1. Arrangement of apparatus at fresh air inlet.

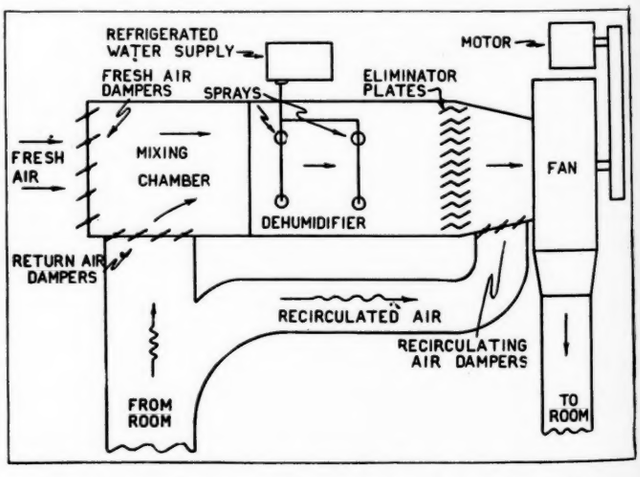


Fig. 2. Arrangement of apparatus for recirculation.

tain parts of the apparatus as now commonly used in installations where the general principle illustrated in Fig. 2 is used for the comfort air conditioning of buildings.

Fig. 1 shows diagrammatically the arrangement of the apparatus as ordinarily installed in the path of the outdoor air before it passes through the fresh air dampers on its way to the mixing chamber shown in Fig. 2. The several items of equipment shown in Fig. 1 are:

1. A screen placed in the outside air opening.
2. Louvers.
3. Fire Shutter.
4. Plenum Chamber.
5. Filters.
6. Air Preheaters.

We will now discuss these several items one by one.

Screen

In certain localities it is advisable to screen the louvered opening to the outside to prevent the accumulation of dirt, leaves, debris and even birds, in the supply chamber. The screen should be made of a copper or bronze mesh with a good free area for the passage of air and calculated on a basis of a velocity of from 500 to 1000 ft. per min., the latter figure being used in general practice and being low enough to prevent excessive noise. The screen should cover the full louvered opening.

Louvers

A method of constructing louvers is indicated in Fig. 4, 24 oz. copper often being used. This arrangement well serves the purpose of keeping out rain and snow while offering but little resistance. In addition, it straightens out the flow of entering air. A slightly less expensive material may be found in copper-bearing iron alloys and a still cheaper one in galvanized iron or steel. Many designers consider it inadvisable to use iron metal in highly humid atmospheres or in localities close to the sea. Special metals may, of necessity, be used in manufacturing districts where smoke or acid laden air is prevalent.

The louvers should be well joined into a metal frame of the same material. Wooden louvers and frames are not recommended, although metal louvers have been successfully used in kalamein frames. Louvers are usually designed on the basis of from 500 to 1000 ft. per min. over the gross area.

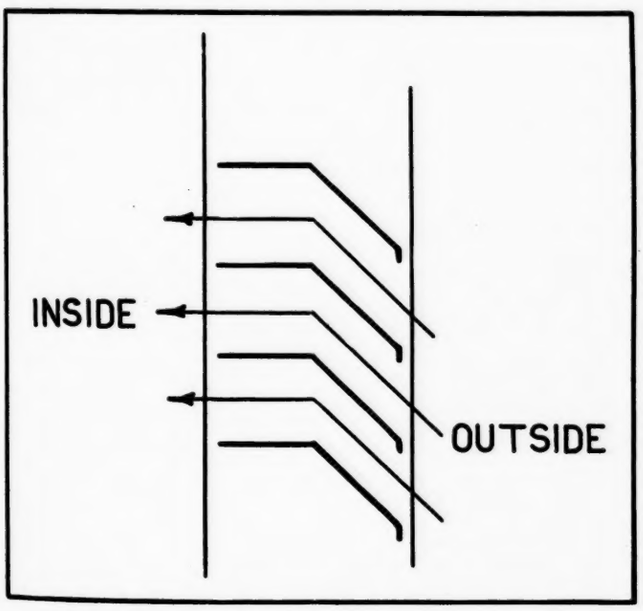


Fig. 4. One method of constructing louvers.

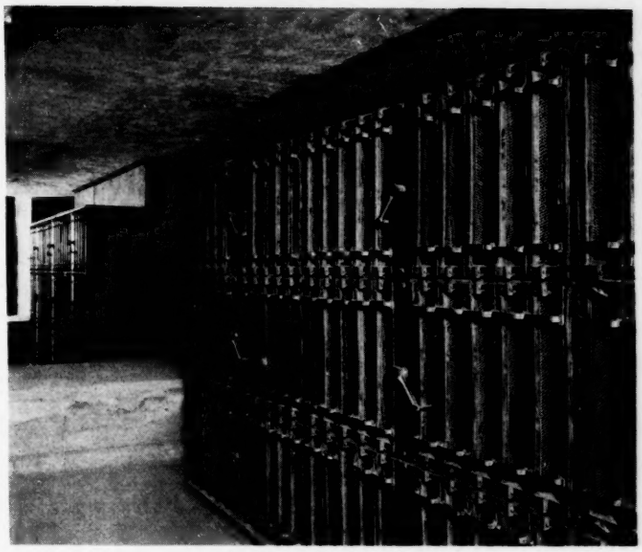


Fig. 3. Mat filter with capacity of 300 c.f.m. per unit.

Fire Shutters

Good design favors the practice of installing fire shutters at the louvers to prevent the spread of fire or smoke into the building from the outside, and to shut off part or all of the outside supply if occasion demands. These shutters may be mounted on either the outside or inside of the building wall. It is good practice to place the shutters on the inside, since this eliminates the unsightly shutter from outside view and maintains the architectural character of the building. The shutters should be designed to operate manually and by a fusible link in case of fire.

Plenum Chamber

In small installations an elaborate plenum chamber is not essential and is usually merely a metal duct leading from the louvered opening to the filters, pre-heater or humidifier.

In larger installations, principally in large office buildings and the like, the plenum is, and should be, carefully constructed with the floor waterproofed and with a drain provided. Floors, walls and ceilings adjacent to occupied or tenanted space should be insulated for cold, since the temperature of the air in the chamber is the same as the outside air, and all surfaces should be neatly cemented and painted to reduce dust accumulation.

Since the air filters commonly form one wall of the plenum chamber, proper space should be provided for their removal and replacement. An adequate access door should be provided which should be weatherstripped. The chamber should be well lighted. In very large installations where the filter stacks extend too high for easy handling of the filters it is good practice to install a light steelwork catwalk for the workmen who clean the filters.

Filters

Several types of filters are in use, of which the two most popular types are perhaps the mat and oil filters.

The mat filter, illustrated in Fig. 3, is rated at 300 c.f.m. per pocket, or unit. The area of the paper mat per pocket is about 8 sq. ft., giving an average of nearly 40 c.f.m. per sq. ft. The nominal pressure drop across the mat filter shown is 0.125 in. of water. The filter may be expected to function satisfactorily up to about 0.4 in. when it should be cleaned. Better practice is to clean the filters when the pressure drop is 0.35 in.

The mats are vacuum cleaned, requiring about one half minute per pocket, for an experienced attendant. The mats will last from six months to a year, the latter being the experience of several large installations that are well maintained. It requires about two minutes per pocket to repaper the mat.

The nominal pressure drop across the oil filter is 0.25 in. of water and may be expected to function satisfactorily up to about 0.5 in., when reconditioning becomes necessary.

Oil filters are constructed of mineral wool packed in a frame. The cell is dipped in an imported, non-odorous mineral oil having a low oxidation value and which is not gummy.

To recondition the cells they are removed from the filter stack and washed and dried. They are then dipped in the oil, the mineral wool becoming impregnated and the cell is left to drain, after which the cell can be replaced in the stack. During this reconditioning another fresh or reconditioned cell is put into the stack.

A hasty comparison of oil and mat filters would seemingly indicate that the required face area of the mat filters would be greater than that of the oil filter. On the contrary, due to the V-shaped design of the mat filter, the actual face area is about one square foot with a velocity of about 300 c.f.m. against about 350 c.f.m. per sq. ft. for the oil filters. Considering construction conditions the filters require about equal face areas. The mat filters do require greater depth.

A draft gauge should be provided showing the drop in pressure through the filters and the attendant should be instructed as to the proper average draft recommended by the manufacturer of the particular filter used and the maximum differential recommended before the filters need be reconditioned. Ample supplies of filter material should be kept in a small room near the filter chamber.

Preheaters

During the winter season, when the outside air temperature is low enough to cause freezing of the spray water in the humidifier, it is necessary to offset this possibility by using the air preheater, which also may be used to assist in controlling the dew point temperature.

In order that the preheater may accomplish both of these purposes, it is usually desirable to have the heat supply controlled both from the cold air plenum chamber and from the spray chamber. One method of accomplishing this (and in common use) is to design the preheater in two parts, one having its supply valve controlled by a thermostat located in the plenum chamber and the other having its supply valve controlled by a thermostat located in the spray chamber. The first bank of the preheater is thus kept hot when the outside air temperature drops to a point which would endanger the freezing of the spray liquid. The second bank operates to control the temperature of the air leaving the preheater in accordance with the desired dewpoint to be maintained in the spray chamber.

In order to determine the requirements of the preheater the following fundamental heat balance formula and examples will suffice. The method here presented while not strictly correct has the advantage of being short and convenient since the chart may be used for the solution, and the results are sufficiently accurate for practical applications.

Assume,

W_r = weight of *return* air in pounds passing through humidifier

W_o = weight of *outside* air in pounds

W_h = weight of air leaving the *humidifier*

H_r = total heat per pound of dry *return* air, saturated with moisture

H_o = total heat per pound of dry *outside* air, saturated with moisture

H_h = total heat of dry air, saturated with moisture leaving the *humidifier*

H_p = total heat per pound of dry air, saturated with moisture leaving the *preheater*

Then,

$$W_rH_r + W_oH_o + W_o(H_p - H_o) = W_hH_h, \text{ from which}$$

$$H_p = \frac{W_hH_h - W_rH_r - W_oH_o}{W_o} + H_o \qquad (1)$$

Assume that we are calculating the capacity of the preheater, the outside air being at 0°, dry bulb. Assume also that the desired condition to be maintained within the conditioned space is such that 70°, dry bulb, and 40% relative humidity are necessary at the outlet

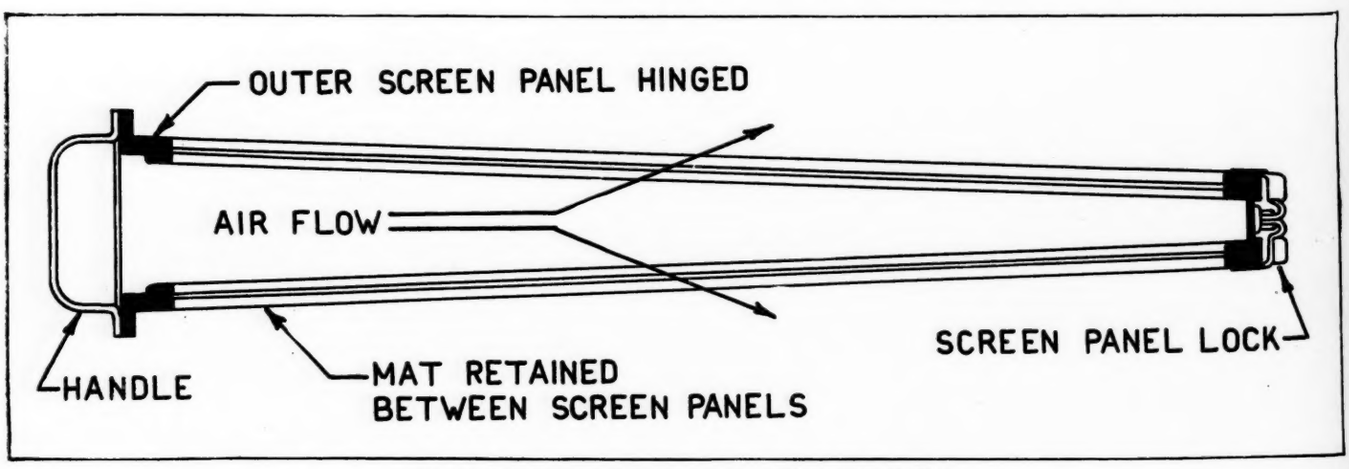


Fig. 5. Detailed section through pocket of mat filter.

of the humidifier. From the chart[1] it will be noted that this corresponds to a dewpoint of 44°. Assume that the return air entering the mixing chamber has a dewpoint of 56.2°. Assume that 1000 lb. of dry air per min. passes through the humidifier, of which 50% is brought in from the outside and 50% is returned air. Then for formula (1), W_h=1000, W_r=500, W_o=500. To find H_h, locate on the psychrometric chart the total heat above 0° contained in one pound of dry air, saturated with moisture. To do this, note that the dewpoint at the exit from the humidifier is 44°. Move vertically upward from 44° dewpoint to the total heat curve and follow horizontally to the left to the total heat scale, reading 17.3 B.t.u. per lb. In similar fashion, using a dewpoint of 56.2°, find H_r to be 23.6 B.t.u. per lb. H_o is 0 in this case, since the temperature of the outside air is 0°.

Substituting these values in formula (1) we obtain

$$H_p = \frac{(1000 \times 17.3) - (500 \times 23.6) - (500 \times 0)}{500} + 0$$

= 11 B.t.u. per lb, of dry air, saturated with moisture. That is to say, when the air leaves the preheater its heat content should be 11 B.t.u. per lb. if saturated. Since the entering air was at 0° and contained 0 B.t.u., each pound of air must have had 11 B.t.u. added while passing the preheater. The total quantity of heat added to the air per minute passing the preheater would be:

$$500 \times 11 = 5500 \text{ B.t.u. per. min.}$$
$$= 330{,}000 \text{ B.t.u. per hr.}$$

Moreover, knowing the total heat content of the air as it leaves the preheater, any other properties of the air can be found from the chart. Thus, the wet bulb temperature is found to be 30°. The temperature rise of the air in passing the preheater can also be found from the chart by following from the 0 total heat point on the scale horizontally to the intersection of the 30° wet bulb line, where it will be noted that the dry bulb temperature of the air leaving the preheater will be 46°.

As a result of the calculation, the preheater should be so designed as to add 330,000 B.t.u. per hr. to the entering air which should have a temperature rise of 46°.

It is interesting to note how the capacity of the preheater would change if all the air passed through the conditioner were outside air. The following example illustrates this condition.

Assume all the conditions as in the previous example except that W_o = 1000 lb. per min. Then W_r = 0 and

[1]Heating and Ventilating, May, 1931, page 81.

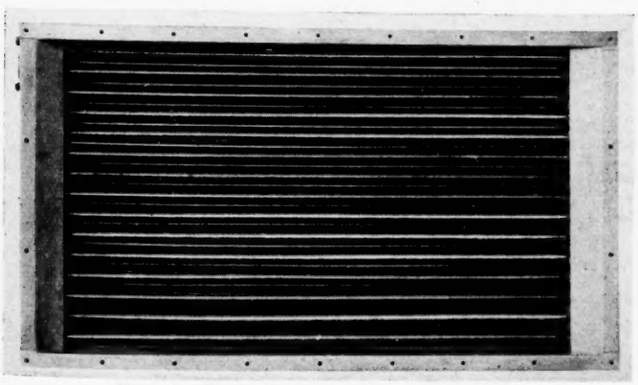


Fig. 7. Extended surface preheater.

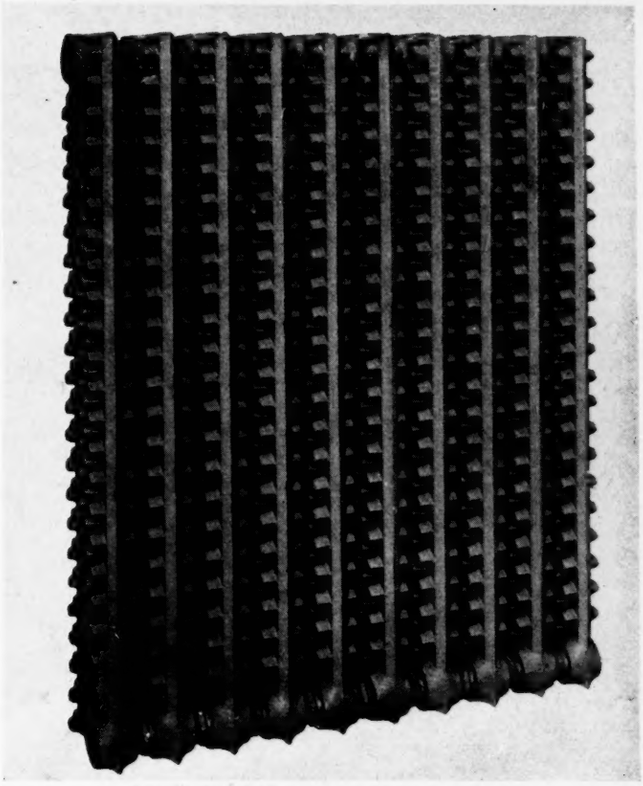


Fig. 6. Cast iron stack for preheater.

H_r = 0, since there is no return air. H_o = 0 since the outside air temperature is again taken at 0°.

H_h = 17.3 as before, since the air leaving the humidifier must again have a dewpoint of 44°.

Substituting these values in formula (1) we have

$$H_p = \frac{(1000 \times 17.3) - 0 - 0}{1000} + 0$$

= 17.3 B.t.u. per lb. of air leaving the preheater.

Since 1000 lb of outside air must be heated from 0 B.t.u. per lb. to 17.3 B.t.u. per lb., 17.3 x 1000 = 17,300 B.t.u. must be added per minute by the preheater, or 1,038,000 B.t.u. per hr.

Note that while the amount of air passing the preheater has been doubled, the heat added by the preheater has more than tripled.

Again, knowing the heat content of the air leaving the preheater, the other properties can be found from the chart as before. Thus, passing horizontally from the 0 heat content scale to the intersection with the 44° wet bulb line the rise in temperature through the preheater is found to be 71°. Under these circumstances, therefore, the preheater should be designed to add 1,038,000 B.t.u. per hr. to the air with a temperature rise of 71°.

When the capacity and temperature rise of the preheater are known, together with the quantity of air to be handled, the dimensional details can be determined. The preheater may be any form of heating device so arranged that it can transfer heat to the air stream. Any source of energy which will produce the required surface temparature could be used. However, in current practice either steam or hot water is the heating medium commonly utilized and the preheater is designed for their use.

Obviously, any arrangement of metal which will withstand the steam or water pressures and transmit

heat to the air effectively can be used. The common arrangements have been to use pipe coils or else specially designed extended surface heaters. The two types of heaters most frequently used are the cast iron and nonferrous fin type. Where space is not of paramount importance and excess weight not prohibitive or undesirable the cast iron type is often used. Due to the more compact construction and lighter weight of the nonferrous heater this type is often favored.

Recommended velocities of air through one make of cast iron heater are given below.

Allowable Air Velocities Through Cast Iron Heaters

No. of Stacks Deep Regular 5 in. Centers	Public Bldgs. Velocity in ft. per min.	Factory Work Velocity in ft. per min.
4	1000 to 1500	1200 to 1600
5	1000 to 1300	1200 to 1600
6	1000 to 1200	1200 to 1600
7	900 to 1100	1200 to 1500
8	800 to 1000	1200 to 1400

The temperature rise and condensation of stock designs are listed in the catalogs of the manufacturers. These tables show the temperature of the entering air, final temperature of the air leaving the heater and condensate in pounds per square foot per hour for various steam pressures and temperatures. It must be carefully noted that the condensate is indicated in pounds per square foot per hour, velocities in feet per minute and entering and final temperatures in degrees Fahrenheit.

Manufacturers also include in their catalogs the friction loss of air through the heaters for given velocities and for the different number of stacks in the heater. They further include the square foot ratings and free areas for the number of sections in the stack and several spacings of the sections.

Sizing the Preheater

Assume the conditions given in our previous problem where 500 lb. of 0° air passes through the preheater, requiring the addition of 330,000 B.t.u. per hr. to the air with a leaving temperature of 46°. Assume also that the available steam pressure is 5 lb. gauge.

Manufacturers' tables are usually based on air velocities calculated at 70°. At this temperature our 500 lb. of air will have a volume of 6680 cu. ft. passing through the heater per minute.

It is good practice to use a velocity through the heater of from 1000 to 1500 ft. per min. From the Vento data book we find that we can obtain a 48° rise from 0° with sections 5⅜ in. between centers and a velocity of 1200 ft. per min., or a 45° rise from 0° with sections 5⅜ in. on centers with a velocity of 1400 ft. per min. The former will result in condensing 2.17 lb. of steam per hr. per sq. ft. of surface and the latter 2.38 lb. per hr. per sq. ft. Interpolating we find that a velocity of 1350 ft. per min. will give us our 46° rise from 0° and a condensation of 2.31 lb. per sq. ft. per hr.

With a volume of 6680 c.f.m. of air passing through at a velocity of 1350 ft. per min. we require $\frac{6680}{1350} = 4.95$ sq. ft. of free area in the heater.

Referring to the capacity tables in the same handbook we find that we can approach the required free area with two size sections. A stack of 9 sections of 30 in. sections has a free area of 4.88 sq. ft., while a stack of 7 sections of 40 in. sections has a free area of 5.12 sq. ft. The heating surface of the 9 sections of the 30 in. stack amounts to 72 sq. ft., and since we require two stacks in the preheater the total heating surface will be 144 sq. ft. Similarly, referring again to the handbook, two stacks of the 40 in. sections have a total surface of 150 sq. ft. The condensation we found to be 2.31 lb. per sq. ft., so that the 30 in. stacks would condense 2.31 x 144 or 330 lb. per hr. The 40 in. sections would condense 2.31 x 150 = 347 lb. per hr.

From steam tables the latent heat of 5 lb. gauge steam is 961 B.t.u. per lb. so that the 30 in. stacks would transfer 961 x 330 = 318,000 B.t.u. per hr. The 40 in. sections, 961 x 347 = 334,000 B.t.u. per hr. The 40 in. sections consequently more closely approach our required 330,000 B.t.u. per hr.

The handbook shows that the dimensions of the two stacks will be

Height 40 15/16 in.
Width 40½ in.
Depth 19⅜ in.

The same handbook also shows details of methods of supporting the stacks, pipe sizes and details of piping connections. It is common practice to provide a hand-operated valve for each stack even where automatic control is included. The friction loss through the heater is found to be about 0.17 in. of water.

Similarly, recommended velocities of air through one make of non-ferrous fin type heater are given below.

Rows of Tubes Deep	Public Bldgs. Velocity in ft. per min.	Factory Work Velocity in ft. per min.
2	1200 to 1600	
3	1200 to 1600	1200 to 1600
4	1000 to 1400	1200 to 1600
5	1000 to 1400	1200 to 1600
6	1000 to 1400	1200 to 1600

Data given in the catalogs of manufacturers of such heaters are presented in almost identical form as those in the Vento handbook and the method of selecting the heater parallels the method outlined.

Steam for Silica Gel Air Conditioning‡

By H. R. WARFIELD, Jr.

THE sources of heat acting on a conditioned area are, generally speaking, conduction through walls and glass, sun effect, lights, infiltration and population. All of these in combination act to add heat to any air circulated through the area and hence to increase its temperature over and above that at its entrance point. The upper limit of this temperature is fixed by comfort considerations. Let us assume that it is 80°F. (the outside

‡Extracts from "Steam as an Activating Agent for Silica Gel Air Conditioning," presented at the 22nd annual convention, National District Heating Association, June 2-5.

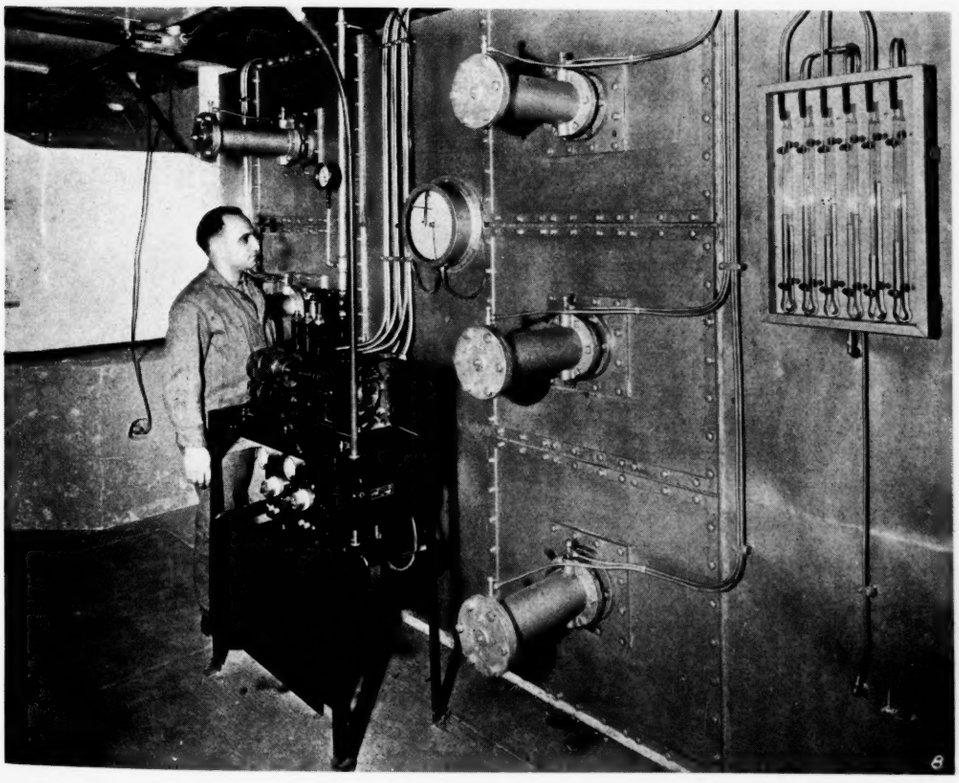
being at 95°). Further assume that the permissible temperature differential through the area is limited to 10°. The entrance temperature must then be 70°, the maximum in the area will be 80° and the circulation required to hold these limits is immediately fixed by the heat load as calculated, the aforementioned temperature differential, and the specific heat of air.

The sources of moisture load generally speaking are infiltration and population. With a knowledge of these factors we can readily determine the weight of moisture added to each pound of air circulated as fixed by the heat calculations just cited. The upper limit of the moisture content is fixed by the relative humidity specified or called for in connection with the upper temperature limit. For example, if in connection with the 80° maximum temperature a relative humidity of 50% is called for, the upper limit of absolute moisture content is fixed at 76 grains per lb. Assuming that the moisture loading calculations show that 6 grains per lb. will be picked up by the air passing through the conditioned area, the inlet absolute moisture content is fixed at 70 gr. per lb. In this particular case then the duty of the silica gel dehydrator would be to effect sufficient drying to reduce the inlet to this point, 70 gr. per lb.

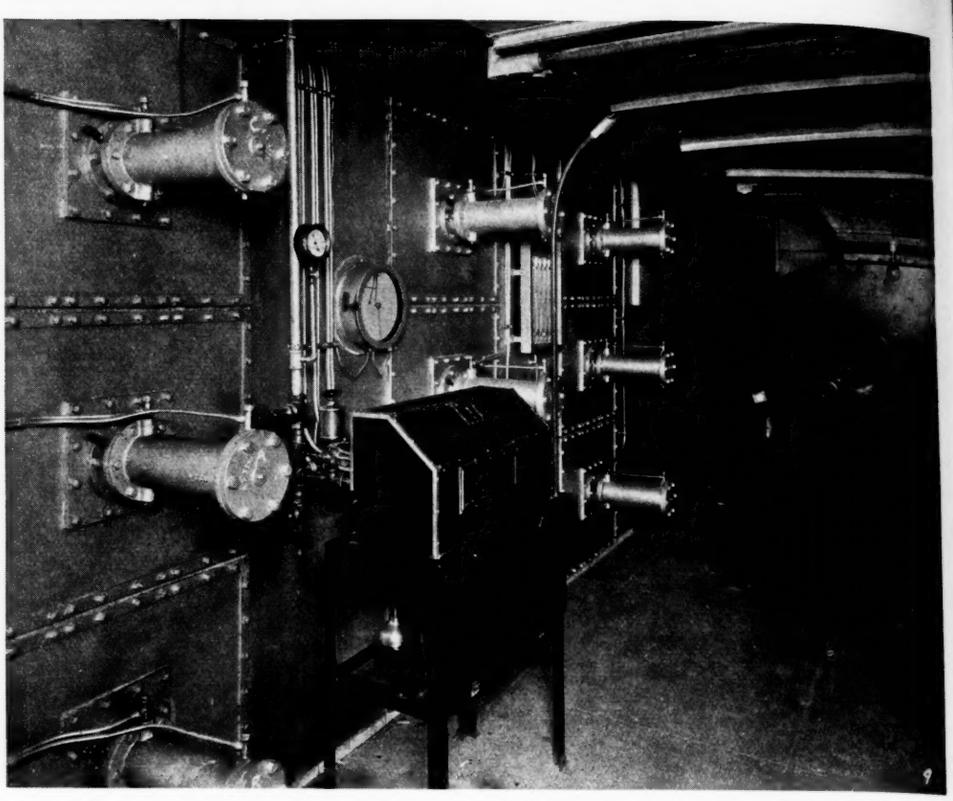
The great advantage of such a system, and one which should not be passed over without notice is that it affords absolutely independent control of temperature and moisture, the two factors of prime importance in conditioning. To elaborate slightly on this idea, keep in mind that the potential head of discomfort in the air surrounding us under severe summer weather conditions is composed of two contributory factors, moisture and sensible heat. May I use the familiar terms latent and sensible heat? In the silica gel system of air conditioning these two are positively and independently controlled. The sensible heat is removed by the cooling water in the indirect cooler sections. The latent heat is removed by the silica gel dehydrator. Thus the system is capable of great flexibility in control and variations in outside conditions can be compensated for to produce the corresponding ideal indoor conditions with the greatest economy and ease.

The foregoing exposition of the independent nature of the moisture and temperature control will quickly lead to the true conclusion that the silica gel dehydrator can and does function in many applications where temperature is of no direct import and where the creating of dry air is the major consideration. By properly proportioning the equipment any degree of dryness required by an industrial or other process can be attained. There are units working to as low as—30° dewpoint. An outstanding example of such an installation is that at the Point Breeze plant of the Western Electric Company where the unit is delivering 12,000 c.f.m. at less than 0.0435 grains per cu. ft. and maintaining in the toll cable storage room a relative humidity of less than ½ of one per cent at 110°.

The standard three adsorber type dehydration unit is fully automatic and continuous in operation. The air to be dried is drawn through a filter from the source of supply by means of a fan and is forced by this same adsorption fan through the unit to its ultimate point of delivery. It will readily be seen that the essential thing is to bring the air to be dried in intimate contact with the porous granules (of gel). This is done by passing the air downward through beds of gel held in multiple horizontal trays with screen bottoms within each adsorber casing. Two stage removal is used. Following the first stage, which comes directly after the adsorption fan, is an intercooler which provides a means for removing the heat of adsorption generated in the first stage as the water vapor in the air gives up its latent heat in passing into the liquid state in the gel pores.



Silica-gel dehydrating unit showing control mechanism.



Side view of silica-gel system. The cylinders are the pneumatic dampers.

This intercooler lowers the temperature of the semi-dried air to a point where the second adsorption stage, similar in every respect to the first, will efficiently perform the final drying or "clean up" of the air flowing through it. The final element in the flow is the aftercooler, the function of which is to remove the heat of adsorption generated in the last stage. Thus the dried air is delivered to the system at a predetermined desired temperature and at a moisture content in the neighborhood of —30° dewpoint or higher as desired.

While this process is in progress the third adsorber is being reactivated. Its adsorbed moisture is being driven off by passing through it a stream of heated air under a negative pressure created by the activation or induced draft fan.

Cycle requires two hours

The adsorption process is continued until the saturation or concentration of adsorbed water vapor in the gel reaches such a point that its efficiency of removal is impaired. When this point is reached the control mechanism automatically shifts pneumatic dampers so that the freshly activated bed is thrown on the line as the second stage adsorber, the erstwhile second stage adsorber becomes the first, and the adsorber which has been functioning as the first stage goes on the activation phase. The average installation is so designed as to have this phase shift occur every 40 min. Thus a complete cycle requires two hours and finds the three adsorbers again performing their original functions.

For our present purposes we are particularly interested in the activation phase—more properly termed the reactivation phase. Physically, the problem is to heat the granules of gel and their adsorbed water to a point where the vapor pressure of this contained moisture will cause it to leave the gel particle and be carried away to the stack by the flow of activating air. The gel will then be returned to its original base concentration, (the concentration below which it is not economical to activate) and will again be ready for service as an adsorbent. Further, this reactivation must be accomplished within the phase time (as above 40 min.) since at the end of this period the bed must again be ready to go on the line.

Air at 325° supplies heat

Thermodynamically the action at the gel bed is as follows. Adsorption takes place at about 80° corresponding to one inch of mercury absolute. The heat liberated to the adsorption air stream is roughly 1050 B.t.u. per lb. of adsorbed water—representing the latent heat of vaporization at that pressure. It is this heat that appears as sensible heat in the air stream and is removed by the intercooler after the first stage to insure efficient removal of remaining moisture by the second stage, and by the aftercooler after the second stage in order to deliver the dried air at the desired temperature. Tests and calculations show that to liberate or drive out this one pound of adsorbed water 1250 B.t.u. are required at the gel bed. Part of this is latent heat of vaporization at the activation partial pressure and part the heat required to bring the gel and surrounding metal up to temperature. Experiment has proven that the most efficient and effective temperature at which to supply this heat is 325° at the bed. Consequently a sufficient weight of air at 325° is drawn through the heater and then through the saturated bed by the activation fan to supply the heat required in the time available.

With an inlet temperature at the bed of 325° the effluent air from the bed will follow a flat curve at about 125° during the period of activation or desorption. As soon as activation is complete this effluent temperature "breaks" sharply upward rapidly approaching the inlet temperature as a limit. This serves as an excellent indicator as to when desorption is complete. A quick cal-

culation will show that between these two limits (325° to 125°), 48 B.t.u. per lb. are given up by each pound of activating air drawn through the bed. Thus the gross heat required for desorption of water vapor, for heating gel and metal, and for radiation losses, in combination with this figure of 48 B.t.u. per pound fixes the amount of air that must be heated for activation purposes.

The air inlet temperature of 325° establishes the most desirable pressure of steam used for activation at 150 lb. per sq.in. gauge corresponding to 366°. At pressures lower than this the final temperature difference becomes too small and the size of the heater increases out of all proportion. In order to give some idea as to the demand created for this 150 lb. steam let us consider the two air conditioning installations now operating in Baltimore, one at the Safe Deposit & Trust Company and one at the Baltimore Trust Company. The former is at present burning gas, the latter oil.

During the conditioning season last summer the Safe Deposit & Trust unit operated for a total of 858 hr. and consumed a total of 1,830,000 cu. ft. of 500 B.t.u. per cu. ft. manufactured gas. The lower heating value of this gas is 460 B.t.u. per cu. ft. which means that the actual heat consumption was 840,000,000 B.t.u. Assuming that the efficiency of a steam heater is practically equal to that of the gas heater on the above jobs (the products of combustion are here mixed directly with the secondary air), then the total consumption of 150 lb. steam would have been 980,000 lb. Putting this on an hourly basis the consumption is 1140 lb. of steam per hr. The unit is a standard 7000 c.f.m installation. The total circulation is 36,000 c.f.m. and the total volume of conditioned space 821,000 cu. ft.

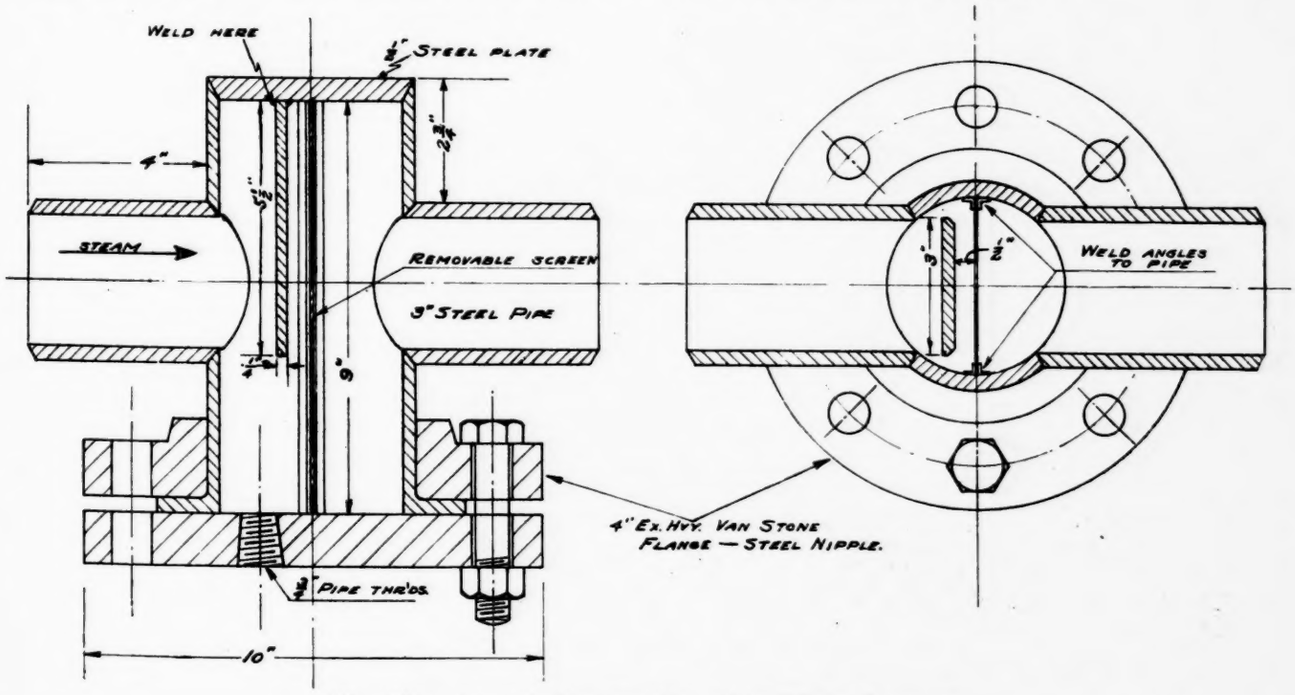
The oil burning unit at the Baltimore Trust Company during the 1930 season operated on a maximum demand of 24 gal. and an average demand of 17.5 gal. per hr. of No. 4 fuel oil. The unit was in operation for approximately 1000 hr. This, by the way is regarded as the normal length of the summer conditioning period. Considering the difference in efficiency between an oil and steam-fired heater the demand here would be 2,600,000 lb. for the season or 2600 lb. per hr. This unit treats 16,000 c.f.m. The total circulation in the building is 65,000 cu. ft. per min. and the volume of the conditioned space is 700,000 cu. ft.

So far as comparative costs are concerned, the 55 cent gas now available to us in Baltimore corresponds to steam at $1.03 per 1000 lbs. To compete with oil on a straight B.t.u. basis the steam must sell at 40 cents per 1000 lb. Needless to say, however, many other considerations than B.t.u. cost of fuel would enter into the picture.

Welded Steam Strainer

THE Ohio Edison Company is using a welded steam strainer fabricated in their own shops, as shown in the accompanying illustration. A particular feature of the strainer is the baffle plate shown in front of the screen.

Several of the strainers have been in use for almost a year, and so far no trouble has been experienced, nor have any of the screens been broken. The device is easily cleaned by removing the bottom flange, which allows all of the screen to be removed. The strainer is made entirely of steel pipe and is therefore just as strong as the pipe which goes to make up the service where it is used.—*P. A. Hyde.*



All-welded steam strainer used by Ohio Edison Company.

Correspondence

Rack Presents Rebuttal in Insulation Thickness Discussion

EDITOR HEATING AND VENTILATING:

The writer deems it unnecessary to consider any further discussion on the methods of calculating insulation thickness than that article which appeared in the April, 1931, issue of HEATING AND VENTILATING. However, some of the statements made by Mr. Close in his answering discussion of the writer's article cannot be allowed to stand without further comment.

In view of the fact (of which we are reminded by the author) that the writer is not the originator of either of the propositions discussed it must be emphasized that the article appearing in the April issue was offered in no spirit of animadversion. For the past nine years the writer has been in direct touch with and has analyzed many and varied problems arising in connection with insulation requirements of all types. For this reason the writer felt qualified to discuss that phase of the subject which the author touched but lightly in his rather voluminous series of articles. The writer was acting solely on his prerogative as a member of a profession which invites cooperation in the form of written or oral discusison on matters of knowledge and experience.

It is acknowledged that the author's Formula A, appearing on page 71 of the August, 1930, issue of HEATING AND VENTILATING, offers *a* method for determining *a* thickness of insulation which will meet *the requirements outlined*. However, in view of the fact that the first part of the author's article introducing this formula brought out that the return on the investment for insulation follows the law of diminishing returns, it was felt that it should be of interest to your readers to continue this phase of the subject.

In commenting on the writer's discussion the author says that the writer "stated that Formula B is similar to a formula presented by the late L. B. McMillan." As a matter of fact what the writer did say was that the two formulas are *equivalent*, not similar. Further, McMillan's formula *does* involve in its usage the return on the final increment of thickness, contradictory to the statement by the author that it "apparently does not."

The author then endeavors to disprove that McMillan intended his formula for use in the building material field. The writer was directly associated with Mr. McMillan from 1922 until the date of his untimely death and has positive knowledge that Mr. McMillan, together with many of his associates, recommended and applied this formula for almost all insulating materials and classes of usage, including building materials and their application.

Due to the fact that Mr. McMillan discussed the derivation and application of this formula in a paper dealing with research of literature specifically excepting the literature pertaining to heat transfer through building materials, the author next endeavors to prove that this formula is not applicable in this field. A biased commentator might as fairly endeavor to prove that other formulas, as well as the fundamental theory of heat transfer (which are discussed by Mr. McMillan in the reference cited) are not applicable for use in heat transfer problems dealing with building materials.

In endeavoring to still further substantiate his beliefs, the author then states that the McMillan formula gives factors for 8760 hr. per year. If the reference cited is consulted it will be seen that it plainly states the variable Y (for use in the formula) represents hours of operation per year. This allows those making use of the formula to substitute their own specific requirements. The reference does, however, give a table of convenient factors in which 8760 hr. per year is specifically stated as having been used. No recommendations or preferences for this constant are offered.

Anyone interested in the subject is further referred to the chapter on "Transmission of Heat by Convection and Conduction" (prepared by Prof. W. H. McAdams) in the third edition of *Mark's Handbook for Mechanical Engineers*. The McMillan formula is obviously approved for use as is signified in its adoption by the editorial staff of this universally recognized handbook. It is distinctly stated in the text that the formula applies to almost all materials. The writer is familiar with more than 30 building insulations, all of which are applicable for use with this formula.

Whether or not the author wishes to subscribe to the writer's statement that the use of insulation cannot be shown to pay for itself if the return on the final increment is set at a point where it is equal to or higher than the overall return, nevertheless, the writer's statement is correct. Under such conditions and as brought out by the writer in his previous discussion, the limit of economic efficiency is reached when the return on the overall investment is equal to the return on the cost of the final increment. At this point insulation thickness becomes zero. If the return on the cost of the final increment is set to exceed the return on the overall cost of insulation, the result (a minus thickness of insulation) will in effect mean the limit of economic efficiency has been passed. It goes without saying that in such a case no one would endorse ripping off a portion of the construction merely in order to make it comply with theoretical requirements.

In concluding, the writer desires to emphasize that he had no criticism to make. There were merely certain assumptions made and steps taken in the author's analysis which seemed to the writer to be open to question. Also, since sound engineering and established business principles as well as the laws of economics apply equally to the building construction field and the arts utilized in it as they do to the industrial field, it is felt that a comparison of the more economic phases with the debatable principle proposed by the author, could, in all fairness to the subject in general, be supplementary to the rather exhaustive presentation which has appeared.

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Abstracts . . .

Reviews and Summaries of . . . Current Papers, Books and Pamphlets

Domestic Gas Appliances

By A. M. Apmann

239 pages, 5½ in. x 7 in., illustrated, semi-flexible cover, published by American Gas Journal, Inc., New York, $2.50 postpaid.

Intended to supply the gas salesman with enough information to let him know his products and their uses.

Although intended for sales purposes the book contains considerable information of a technical nature. Chapters are included on fuel characteristics, fuel prices, and comparative fuel costs, which include statements of efficiencies and methods of estimating. Pipe capacities, meters and gas orifices are treated in such a way that the principles and operation are made clear. Much space is devoted to descriptions of existing types of gas-fired furnaces, boilers and radiant heaters; to laundry equipment, hot water heaters and to the gas refrigerators. A series of questions and problems is included at the back.

A very useful book, and one that should be of interest to all who deal with domestic gas utilization.

●

The Effect of Humidity on Heat Transmission of Pipes

By W. R. Woolrich

Refrigerating Engineering, June, 1931, page 417, about 3000 words, 13 graphs, 3 tables.

Results of a laboratory study in which a 1¼ in. pipe was placed in a current of air under controlled conditions to study the effect of humidity on the heat transfer rate. The paper contains a table of the properties of saturated steam using 0°F. as a base instead of the customary 32°F., as computed by the author by extrapolating existing data. Following summary is appended:

1. When air is heated by passing it over a warmer surface, the cooler air passing over the warmer surface has its per cent of relative humidity reduced. Under these conditions the humidity condition itself has no influence on the heat transfer rate.

2. When air is cooled by passing over a cooler surface, the warmer air passing over the cooler surface has its percentage of relative humidity increased. Under these conditions, the humidity condition itself has no apparent influence on the heat transfer rate so long as the dew point is not exceeded.

3. When air is cooled by passing over a cooler surface, and the relative humidity increases beyond the dew point, the heat transfer rate greatly increases as the moisture released increases.

4. Since air at high room temperatures contains more moisture for the same relative humidity, and since the warm air at any given humidity will reach the dew point with less temperature drop than the cooler air, and further, since the heat transmission transfer rate increases as soon as the dew point is passed, it follows that the resultant heat transfer rate in cooling air in a warm room is often greater than the heat transfer rate in cooling air in a room of the same humidity.

5. The heat transfer rate will be equally effected for black and for galvanized pipe.

6. Air at any given temperature passing over a very cold cooling surface reaches its dew point with a lower original humidity than the same air passing over a cooling surface of higher temperature. But the rate of increase of the heat transfer rate with humidity is slower for air passing over the cooler surface.

●

Some Observations on the Performance of Stokers in Firebox Boilers

By C. E. Bronson

A paper presented at the second Midwest Coal Conference at the University of Illinois, May 21-22, 1931.

Summarizes some of the results of the author's tests with stokers installed in fire-box boilers. No schedule of the stokers used during the study is included nor any detailed tables showing the full results obtained. Southern Illinois bituminous coal was used during the tests. The stokers were operated continuously, and the heat output was measured by the use of a surface condenser and separator.

The author observes that the difficulty of judging the condition of the fuel bed at the start and stop of the test period is particularly acute with underfeed stokers, and feels that extra care must be exercised to close the test cycle.

It appears that these tests tend to bear out the figure of 50,000 B. t. u. per hr. per cu. ft. of furnace volume as being the maximum allowable if smokeless combustion is to be obtained. The author also notes that the furnace doors should be carefully located and that they should be as near the side wall as possible and at least eight inches above the stoker dead plater.

Regarding the sizing of the stoker, the author states: "To guard against unsatisfactory installation, the selection of the proper size stoker for a particular load

Copies of books or papers abstracted on these pages should be ordered direct from the publishers.

should be made with care. All stokers with a screw feed will handle more coal per hour with screenings than with nut coal. On the other hand, the same stoker will not burn screenings as fast as it will nut coal on account of air pressure limitation. Economical operation seems to demand the use of screenings, and the choice of the stoker should be made so that it will not be necessary to change to nut coal in order to develop the higher outputs required."

He also feels that full safety features should be included in the stoker installation intended to operate intermittently, and mentions the use of a low-water cut-off device as being especially desirable.

●

Flow of Steam Through Orifices Into Radiators

By S. S. Sanford and C. B. Sprenger

A. S. H. V. E. paper, semi-annual meeting, Swampscott, Mass., June, 1931. About 4,000 words, 3 charts and photos, 7 graphs, 5 tables.

An account of a series of tests conducted by the authors to learn the flow characteristics of orifices used in steam lines at the entrance to radiators, together with the results obtained.

Test apparatus consisted of a radiator immersed in a cold water tank into which radiator steam was caused to flow through the orifices to be studied. Suitable apparatus was provided to control both the pressure in front of the orifice and the pressure in the radiator. Precautions were taken to insure dry steam.

The orifices used varied in diameter from 3/32 in. to ¼ in., and in thickness from 0.019 in. to ¼ in. The initial steam pressure in front of the orifice covered a range from ½ in. of mercury to 6 in. of mercury. The radiator pressures used during the tests varied from atmospheric to 20 in. of mercury vacuum. Two makes of radiator valves were used but no difference in the orifice characteristcs resulted from their use.

The authors' results agree with those of previous experimenters and with well known facts concerning orifices placed in fluid flow piping. The experimental results show that the flow is not strictly proportional to the pressure drop, and that it does depend on the initial pressure. The formula of Moyer which is often used for calculating the flow of steam through nozzles is

$$W = \frac{AP^{0.97}}{60}$$

where W = weight of dry steam discharged, pounds per second,
A = area of orifice, square inches,
P = absolute pressure, pounds per square inch.

This formula makes the flow depend on the initial pressure and is intended to apply only to cases where the critical pressure is not reached. The authors plot their results against those of Rateau and find that their thin orifice results agree closely with his results with a thin-plate orifice, while theirs with a thick orifice approach the values of the Moyer formula. From this they conclude that the flow of steam through thin orifices in radiator unions can be calculated by the above formula if modified by the factors found by Rateau.

The authors also found that the placing of the orifice in the union end of the tail-piece of the valve resulted in a greater actual flow than when placed in the discharge end of the tail-piece even when like pressure drops were maintained across the orifice.

The following table shows the size of 3/32 in. thick orifices which should be used with various sizes of radiators if a 6 in. mercury drop in pressure is required to keep the radiator full of steam. With a 6 in. of mercury pressure drop the noise of the steam rushing through the orifice does not seem excessive.

Sizes of Radiator Orifices

Orifice Diameter (Inches)	*Size of Radiator (Sq. ft.)*
3/32	18
7/64	24
1/8	30
9/64	37
5/32	44
11/64	52
3/16	61
13/64	70
7/32	80
15/64	91
1/4	102

The following table shows the pressure drop required at the orifices with various outside air temperatures if the orifices are sized in accordance with the preceding table, and if the radiators are proportioned to 70° and 0° temperatures at peak conditions, assuming atmosphere pressure in the radiators and that the steam required varies with the outside temperature changes.

Required Pressure Differential Across Orifices for Different Outdoor Temperatures to Maintain 70° Inside

Outdoor Temperature °F.	*Pressure Differential (In. of Mercury)*
0	6
10	4.5
20	3.2
30	2.1
40	1.2
50	0.5
60	0.1

The authors state that orifices may be cheaply installed and include some operating data showing that decreased steam consumptions have been secured with orifice installations.

●

Refrigerants and Refrigeration in Air Conditioning

By R. W. Waterfill

Paper presented at the 22nd annual convention of the National District Heating Association, Boston, June 2-5, 1931.

THE several classes of application of refrigeration to air conditioning are listed as: comfort, industrial, and low temperature. The extreme importance of safety and the steps being taken to promote it are mentioned.

The author feels that simplicity, flexibility, and automatic control are more important than laboratory efficiencies.

He reviews the three cycles in use for air conditioning

refrigeration, viz.: compression, absorption, and adsorption.

The author draws up a numerical comparison between the absorption and mechanical system, as follows:

"Direct comparisons between the absorption and the mechanical systems are difficult, chiefly because more steps enter into the absorption cycle. Table 1, however, will indicate how heat energy in the form of steam is converted into refrigerating effect through the absorption system. It is assumed for simplicity that perfect heat interchange between the weak and strong liquors is obtained, or rather, that the strong liquor enters the generator at generator temperatures, and the weak liquor enters the absorber at absorber temperatures. In practice this circulation of the absorbing fluid is a critical factor.

TABLE 1.

Steam Driven Ammonia Compression and Absorption Systems

	NH_3 Compression	*NH_3 Absorption*
Evaporator temperature	30°F.	35°F.
Refrigerant condenser temperature	100°F.	100°F.
Steam temperature	200°F.	200°F.
Steam condenser temperature	100°F.	
Absorber temperature		100°F.
Rectifier temperature		100°F.

"With these parallel temperature conditions, the following theoretical heat balances, adiabatic refrigerant compression and steam expansion occur per ton refrigerating effect (B.t.u. per min.).

Refrigerant evaporator (output)..	200	200
Refrigerant condenser and rectifier	231	279
Steam evaporator or generator (input)	211	279
Steam (lb. per hr.)	11	14.5
Steam condenser or absorber	180	250
Heat removed by cooling water...	411	529
G.P.M. cooling water—80°ent., 95°leav.	3.3	4.21
Compressor 0.73 H.P.=.....	31 B.t.u.	

"If electrical or other high-grade energy is used this becomes:

Refrigerant evaporator (output)..	200	200
Refrigerant condenser and rectifier	231	279
Absorber		250
Energy (input)	31	279
Heat removed by cooling water...	231	529
G. P. M. cooling water—80°ent., 95°leav.	1.85	4.21

"In the absorption system there are two temperature and concentration equilibriums to consider. These determine the useful concentration of refrigerant circulated with a given amount of absorbent and the efficiency is correspondingly affected. There is a condition, an equilibrium condition, in which the absorbent may circulate carrying no useful refrigerant, but absorbing energy in being alternately heated and cooled. This is somewhat similar to a reciprocating steam water pump with equal cylinders on opposite ends of a common rod. If the steam pressure does not exceed the water pressure no work will be done, but in the absorption cycle the energy, absorption and water consumption continues.

"The cooling water requirements are large, because the motive energy used is thrown into the refrigeration cycle. This must be removed at relatively low temperatures in order not to react on the primary cycle requiring more energy. This is generally true of direct thermal machines, but is particularly important where the temperature differences are small. For instance, the absorption system outlined in table 1 appears theoretically satisfactory, but it would have considerable difficulty producing under the conditions.

"With a mechanical system the machine might be likened to a lever, permitting energy of any temperature potential to produce refrigeration of any other temperature potential.

"The steam turbine is one of the most flexible power machines and can satisfactorily use steam of almost any pressure. Its best operation is obtained at comparatively high speeds, however. The centrifugal refrigeration compressor has similar operating characteristics, and a direct coupled unit possesses marked flexibility. Operating steam pressures as low as 1 lb. gauge have been satisfactorily employed with condenser water at 80° F."

The theoretical requirements for 200°F. steam, using carrene, are:

Turbine Driven Centrifugal Refrigeration System (1 Ton)

	Refrigerating Machine	*Turbine*
Evaporator temperature	35°F.	
Condenser temperature	100°F.	116°F.
Condenser work (B.t.u. per min)...	229.6	235
Condenser water temperature	80° ent., 95° leav.,	95° ent., 110.4 leav.
Condenser water G.P.M.	1.83	Same water
Evaporator work (B.t.u. per min)...	200	264.6
Steam temperature		200°F.
Work required (.70 b.hp.	29.6 B.t.u.	
Steam required (Lb. per hr.).....		13.9
Ration refrigeration per work =....	6.75	

●

Care and Repair of the House

By Vincent B. Phelan

Building and Housing Publication BH15 of the Department of Commerce, Bureau of Standards, issued March 31, 1931. 121 pages, 6 in. x 9 in. Obtainable through the Superintendent of Documents, price 20c.

A comprehensive booklet on the subject covering practically all items of common occurrence. One chapter deals with weatherproofing and insulation while another treats of heating and ventilating. Subjects covered include filling the system, insulation of pipe lines, furnaces and hot water tanks, repacking radiator valves and mending grates. The booklet is addressed to the householder and is intended for his information.

●

Comparison of Roof and Ground Exposure of Thermometers

By Bernard R. Laskowski

Monthly Weather Review, U. S. Department of Agriculture, Weather Bureau, February, 1931, pages 77-79. About 1100 words, 1 table. Obtainable through Superintendent of Documents, 15 cents.

Report of a study made in Topeka, Kansas, over a period of six years in which the readings of daily maximum and minimum temperatures were taken on the roof of a six-story building and at a location in the suburbs with the thermometers near the ground.

Regarding the thermometers, their location and the nature of the test period, the report states the thermometers were "of standard pattern, compared for accuracy, and exposed in standard shelters having

louvered sides and double-decked roofs. These favor the free circulation of the passing air, but do not absorb any added heat due to radiation or reflection from nearby objects or from the direct rays of the sun. One set, that of the Weather Bureau office, was located 10 ft. above the flat roof of a six-story building, making an actual elevation of thermometers 92 ft. above street level, in the center of the business district, and the other 5½ ft. above the ground at a point a mile and a half away in the residential section. The size of the ground shelter is 21 x 32 in.; it has not a broad platform underneath it. The ground surface at both places is approximately the same elevation above sea level.

"During the period of comparative readings some of the lowest readings ever recorded in the vicinity, as well as the highest on record in 44 years, occurred. This should eliminate the objection that just average conditions had prevailed during the experiment and extreme conditions might have altered the results obtained.

"The ground-exposed maximum thermometer averaged 1.9° higher than the roof thermometer, while the minimum readings averaged 0.6° less. This may be accounted for by stating that the radiation effect at the ground should be greater than on the roof, where air passage is less hampered."

The individual monthly averages obtained from the ground surface readings were higher in most cases and wind movement and the presence of snow and ice on the ground seemed to be the most apparent factors in making the differences.

Regarding the monthly mean maximum and minimum temperatures and extremes the report notes that: The daily extremes serve to bring out examples of the various factors which tend to separate or draw together the readings, and several examples are quoted which tend to show that as the wind velocity increases the readings of the thermometer in the two locations come more and more closely together. This seems to be accounted for by the movement of the air mass past the thermometer bulbs. On days with little wind movement the greatest differences between the readings in the two locations were found as the radiation effects became greater with relatively stagnant air around the bulbs.

With reference to the effect of a snow blanket:

"For cases to demonstrate what effect a snow blanket has on the ground temperature we refer to the period of January 12-16, 1927. Snow several inches in depth occurred on the 12th and 13th, leaving four inches on the ground at the close of the 13th. The next morning with a clear sky and wind averaging 10.2 miles per hour, the ground thermometer registered 5° while the roof thermometer registered 8°. Practically the same sky and wind conditions prevailed through the 16th. On the 15th the ground thermometer read 14° below zero and the roof thermometer 9° below zero. On the 16th the ground minimum was 16° and roof reading 23°. The period of January 22-25, 1930, also illustrates this point. Previous to the 22nd, snow had fallen and the ground was covered to a depth of 9.0 in. The sky was clear from the night of the 21st to the morning of the 25th. The average wind movement the 21st to 22nd was about 5 miles an hour. The ground thermometer that morning read 19° below zero and the one on the roof read 13° below zero, which by the way, is the lowest recorded at the Weather Bureau in 11 years. The wind movement from the 23rd to the 25th averaged between 9 and 10 miles per hour. On the morning of the 23rd, the ground reading was 7° below zero while the roof reading was 1° above zero. On the 24th the low point at the ground was 9° compared to 12° on the roof. The morning of the 25th the ground thermometer indicated 3° and the one on the roof 11°."

An interesting fact was that the daily maximums did not show as great variations as did the daily minimums, since the maximum usually occurs when the wind movement is also greatest.

The report included the following table:

TABLE 1.—*Summary of comparative readings, monthly means, and extremes*

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Monthly means, ground.	26.9	37.6	46.3	57.1	64.9	73.0	79.6	77.6	70.5	57.8	43.2	31.8	55.5
Monthly means, roof	26.6	37.0	45.0	56.0	64.4	72.2	79.0	77.3	69.8	57.9	42.6	30.8	54.9
Monthly means, maximum ground	36.9	48.7	58.9	68.8	76.5	83.9	91.2	89.2	81.8	69.4	54.0	42.0	66.8
Monthly means, maximum roof	35.6	46.7	56.1	66.1	74.8	82.0	89.3	88.0	80.0	68.4	52.3	39.9	64.9
Monthly means, minimum ground	16.9	26.5	33.7	45.5	53.3	62.1	68.0	65.7	59.2	46.1	32.3	21.6	44.2
Monthly means, minimum roof	17.6	27.4	34.0	45.9	53.9	62.4	68.7	66.6	59.6	47.4	32.9	21.7	44.8
Absolute maximum, ground	66	83	89	93	95	99	105	110	102	93	83	68	110
Absolute maximum, roof	68	83	88	93	96	100	104	110	101	93	84	68	110
Absolute minimum, ground	−19	−11	0	14	34	46	51	49	35	16	5	−9	−19
Absolute minimum, roof	−13	−7	4	17	35	49	52	52	38	16	10	−9	−13

The whole study is very significant both to those who are in the habit of collecting their own temperature data with little thought as to where the observing station is located and to those who attempt to make comparative studies in different cities of fuel or steam consumption based either on their own or on weather bureau figures. Some weather bureau figures are reported from stations located on high buildings while others are from ground stations.

Assuming a 70° maintained temperature the temperature difference as observed on the ground station report would be 89°, while on the basis of the high station it would be 83° on the day of lowest temperature in Topeka. This is a variation of over 7% based on the ground station report being correct.

●

Standards of The Hydraulic Society

Sixth edition, 96 pages, 8½ in. x 11 in., paper binding, well illustrated. Obtainable through the secretary, 90 West Street, New York.

Contains a statement of the standards applying particularly to matters of nomenclature and testing, some rather complete classifications, operating and installation recommendations, tables of pipe friction, and a table showing the materials for use when pumps handle various kinds of liquids, including brine, oil and water. The engineer who specifies pumps for a variety of uses should find the book very valuable. An interesting inclusion is some new charts showing the pipe friction when paper stock is pumped through cast iron pipe.

News of the Month

Optimism of Utilities Reflected at District Heating Convention

If convention attendance is any basis for judgment, it is evident that utility district heating is suffering very little or not at all from the current depression, for the attendance at the twenty-second annual convention of the National District Heating Association reached a total of about two hundred. In point of size, therefore, the convention, held at Boston, June 2-5, was among the largest ever held.

The increase in interest in district heating was also plainly shown by the general excellence of the whole program and by the spirit of the discussions which took place. The association and its committees are actively attacking the problems as they arise and the reports this year contained a wealth of information.

One of the major changes which is gradually taking place in the utility field is the recent development of combination steam and electrical plants of which some half dozen are now in operation. The principal features of the existing plants were described in a committee report and served to show that while the details of these existing plants are greatly different, considerable progress is being made in the promotion of the general idea of locating combined heating and electric-generating plants at points of large industrial load It has been freely predicted that the large scale development of such plants will revolutionize electrical generating plants.

Among the interesting features of the convention were the papers dealing with the subjects of meters and metering. Serious thought is being given to the metering problems and it is apparent that both the instruments and the practice are improving notably.

Some noteworthy steam consumption figures for a wide variety of buildings were reported as the result of the activity of the commercial relations committee. The results obtained in the operation of the heating plants of these buildings give an inkling as to the economies which may be reasonably expected from installations of modern equipment in buildings. A wide variation in the results obtained is still evident, and the figures as reported show plainly that there is as yet no decision to be drawn on the subject. Steam consumptions are variable depending on the individual building.

Since air conditioning has recently come into considerable prominence in large buildings, the papers by R. W. Waterfill and H. R. Warfield aroused much interest when presented. Mr. Waterfill reviewed the properties of the commonly used refrigerants, while Mr. Warfield explained the nature of the air conditioning process using silica gel as a dehumidifying agent and outlined the method of applying steam to the deactivation of the gel. It is apparent that the use of steam has considerable possibilities in air conditioning applications.

Corrosion of piping in some heating systems has long been a matter of difficulty and studies on the subject have been in process for a period of several years. James Aston described some of the laboratory work that has been done and also ably summarized much of the interesting information on the subject. The committee on corrosion reported on its efforts during the year and it is apparent that the subject is being closely examined in its fundamentals. There is also a considerable likelihood that the major points will not only be rather definitely known soon but that practical working information both to predict the presence of corrosion and to prevent its action will soon

B. & O. inaugurates all-air-conditioned train

The illustration below shows the *Columbian*, the all-air-conditioned train placed in service by the Baltimore & Ohio Railroad, May 24. The train makes a daily run between New York and Washington, D. C. The view to the left shows the interior of one of the colonial type air conditioned diners. The *Columbian* is the first train to be completely conditioned.

be available. Studies are now under way indicating that the limits of corrosive action in the generated steam will be predictable and that feed water treatment can be readily developed and applied which will eliminate corrosive action by the generated steam.

Harry T. Bussman, of the Bussman Manufacturing Co., St. Louis, in his address to the convention on the subject of sales promotion, brought out clearly the necessity of the preparation of an intelligent sales appeal. His address was one of the features of the meeting.

Manufacturers of equipment related to the field exhibited several new developments from which it is evident that serious thought is being given to the possibilities in the way of apparatus. New instruments, meters, metering developments and an interesting new form of underground construction were exhibited and described.

W. W. Stevenson of the Allegheny County Steam Heating Co., Pittsburgh, is the newly-elected president of the association. Vice-presidents elected for 1931 are: E. E. Dubry, Detroit; J. E. Seiter, Baltimore, and W. J. Baldwin, Jr., New York.

Social features of the program with the background of the very great many places of historical interest around Boston were unsurpassed by any recent convention. The program, which included visits to many of these points as well as dinners and the annual banquet, reflected clearly the great amount of attention which the local committees had given to it.

Charles L. Edgar, president of the Edison Electric Illuminating Company of Boston, in welcoming the convention, brought out forcibly the fact that many of the major utility executives are now quite convinced of the value of utility steam services and expect to adopt such divisions wholeheartedly. Mr. Edgar even went so far as to predict that residential districts may be reached by such service in the not distant future.

President Landis Charles Smith in the annual address spoke most entertainingly of the work of the association during the year and outlined some of the projected plans. That the association is in excellent shape was shown by the report of the secretary, D. L. Gaskill.

Federal Trade Commission to Investigate Letting of Government Building Contracts

The Federal Trade Commission recently has undertaken an investigation of the building material industry. Preliminary work is now under way.

In the inquiry the commission will investigate and report facts relating to the letting of contracts for the construction of Government buildings, particularly with a view of determining whether or not there are or have been any price fixing or other agreements, understandings or combinations of interests among individuals, partnerships or corporations engaged in the production, manufacture or sale of building materials with respect to the prices or other terms at or under which such materials will be furnished contractors or bidders for such construction work and that the chief examiner make such investigation and report to the commission.

Booklet on Wrought-Iron Pipe Nipples Available

"Wrought-Iron Pipe Nipples," commercial standard CS6-31, a 14-page pamphlet, containing the standards which have been accepted by the industry, has been published by the Department of Commerce. Copies can be obtained from the Superintendent of Documents, Government Printing Office, Washington. Price 5 cents.

Oil Burner Manufacturers To Hold Trade Conference

A general conference of oil burner manufacturers to discuss the unethical trade practices which have been confusing to the public and harmful to the industry will be held at the Royal York Hotel in Toronto on July 13, it was decided at a recent meeting of the executive committee of the American Oil Burner Association. All manufacturer members of the American Oil Burner Association will be urged to attend.

Walter F. Tant, of Detroit, president of the association, in announcing the conference, said particular attention would be paid to vicious and unethical practices arising from intense competition "which are not productive and lead to business failure." The conference also will examine in detail unethical and unfair advertising.

The manufacturers also will discuss the problems of the dealers in recognition of the importance of a live and vigorous dealer organization.

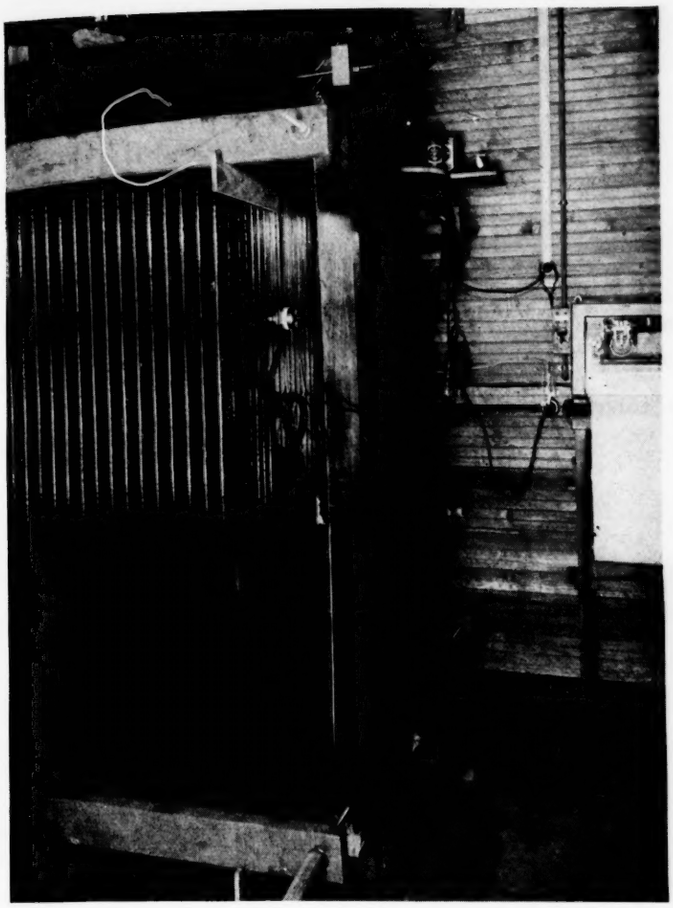
White House Cooling System Installation Postponed

Reports from Washington, May 26, state that President Hoover has ordered the postponement of the installation of an air conditioning system in the White House, his purpose being to set an example of economy.

The following day the New York *Sun* commented editorially on the order, saying that in their opinion the American people do not wish the sort of economy that will deprive the chief executive of any equipment which will make him comfortable and contribute to his efficiency. The editorial suggested that the President proceed to have the cooling system installed and then sit down in his cool office and devise means to check the far more serious expenditures of Congress.

New York State Amends Professional Engineers License Law

At the last session of the Legislature of the State of New York an amendment to section 1457 of the present engineers license law was passed. The amendment states that evidence must be submitted by the applicant for a professional engineer's license that he is: More than twenty-five years of age; a citizen of the United States or has legally declared his intention of becoming a citizen; of good moral character; has satisfactorily completed a four year high school course or the equivalent thereof approved by the department, and such further educational requirements as the department may determine; has had eight



Courtesy U. S. Bureau of Standards

Completely assembled apparatus being used by the Bureau of Standards for measuring the heat transfer through building walls. It was found, in general, that the data agreed satisfactorily with those of other experimenters.

years or more of practical experience in professional engineering work of a grade and character satisfactory to the board; has successfully passed the prescribed examinations.

Prior to January 1, 1937, the board may exempt from all or any part of the examinations, a graduate of a college or school of engineering registered by the department as maintaining satisfactory standards. New York engineering colleges and schools and New York engineering students shall not be discriminated against by the registration of any college or school out of the state whose minimum graduation requirements are less than those fixed for New York engineering schools. Each complete year of study in such registered college or school of engineering may be accepted in lieu of one year of experience.

Subsequent to January 1, 1937, before admission to examination, every applicant for a certificate of license as a professional engineer shall be required to submit, in meeting the educational requirement or such part thereof as the department may determine, evidence that he has graduated from a college or school of engineering registered by the department as maintaining satisfactory standards, and that prior to entrance to such school or college he has satisfied the prerequisites for admission thereto. In lieu of such graduation, an applicant may be admitted to the examinations upon presenting evidence of at least twelve years of practical experience in professional engineering work satisfactory to the board.

The fee for a certificate of license as professional engineer shall be $25.

Smoke Prevention Convention to Be Held in Grand Rapids

The Smoke Prevention Association will hold its twenty-fifth convention at the Hotel Pantlind, Grand Rapids, Mich., June 30-July 3. Three days will be devoted to the technical sessions of the meeting, and the fourth day to plant inspection and sightseeing. On June 30 the main themes will be smoke abatement in heating plants, and legislation. Smoke abatement in power plants and separation of solids from chimney gases are the subjects for discussion July 1.

Plans are being made for a conference on July 1 on standardizing setting heights and furnace requirements for fuel-burning equipment. Representatives from the following organizations have been invited to attend: American Boiler Manufacturers Association, Midwest Stoker Association, Fuels Division of the American Society of Mechanical Engineers, American Oil Burner Association, National Piping and Contractors Association, Cast Iron Boiler and Radiator Manufacturers, and the Steel Heating Boiler Institute.

Another question of importance slated for discussion at the convention is the removal of solids from chimney gases. Air pollution from this source is given on the average as 50 lb. of solids per ton of coal burned. The presence of experts in the field is anticipated and it is hoped that an agreement will be reached on definite standards for fly ash removal.

Among the papers on the tentative program are: "Court Action vs. Education," James E. Carey; "Smoke Ordinance Enforcement," Gordon Rowe; "Legislation for Smoke Prevention," Senator Conlon of Grand Rapids; "Smoke Abatement with Warm-Air Furnaces," V. W. Cherven; "Central Heating," A. W. Kastens; "Purposes and Activities of the Committee of Ten," Oliver J. Grimes; "Measurements of Smoke Densities and Soot Fall," W. A. Carter; "Boiler Practice," I. J. Van Kammen; "Heating with Gas Coke and Gas Firing," George D. Holliday; "Five Years' Progress in Direct Steaming," L. G. Plant; "Standard Setting Heights for Domestic Stokers,"

News of the Month

E. L. Beckwith; "Fly Ash Collection in the Detroit District," Charles J. McCabe; "Smoke as a Menace to Public Health," Dr. Edward Slemons.

New York Body Asks Inquiry Into Coal Prices

According to Isidor Berger, general manager of the Greater New York Taxpayers' Association, said to represent 7000 realty owners, an investigation into coal prices in New York City is under way by the attorney general's office. The organization has protested an alleged increase in price of pea coal and buckwheat last spring.

According to Mr. Berger, apartment house owners generally buy their winter supply of coal about June every year to take advantage of low spring and summer prices. This year, however, the Greater New York Taxpayers' Association has advised its members not to buy. Mr. Berger said this had affected about 50,000 buildings, each using from 125 to 600 tons of coal a year, bought at an average of $8.50 a ton.

About 70% of the coal used in apartment houses now is pea or buckwheat coal, Mr. Berger said. Formerly, he asserted, this coal was not widely used here, but when coal dealers persuaded property owners to install smaller grates, a market was created. This year's prices on pea and buckwheat coal, Mr. Berger charged, run from 10 cents to $1 per ton more than last year.

U. S. Comptroller's Decision Hits Shopping of Bids

Shopping of bids and log rolling tactics with reference to Federal Government construction contracts were dealt a fatal blow in a far-reaching decision recently handed down by United States Comptroller J. R. McCarl ordering the abrogation of the $4,600,000 contract for construction of the new Federal post office at Boston, Mass.

The contract was awarded by the treasury to N. P. Severin Co., Chicago, who submitted the lowest bid after the department had several times called for supplemental bids by contractors who bid on original specifications advertised by the Government. The Comptroller holds that the revised specifications should have been readvertised and his decision will affect the entire government building program throughout the country.

Pointing out that in the supplemental bidding the Severin Company reduced its original figure $1,029,600, despite the fact that more costly material was specified, the Comptroller General's decision declared that the contract was not let after advertising, as required by law, nor in conformity with the public policy of maintaining "full and free competition in the letting of Government contracts."

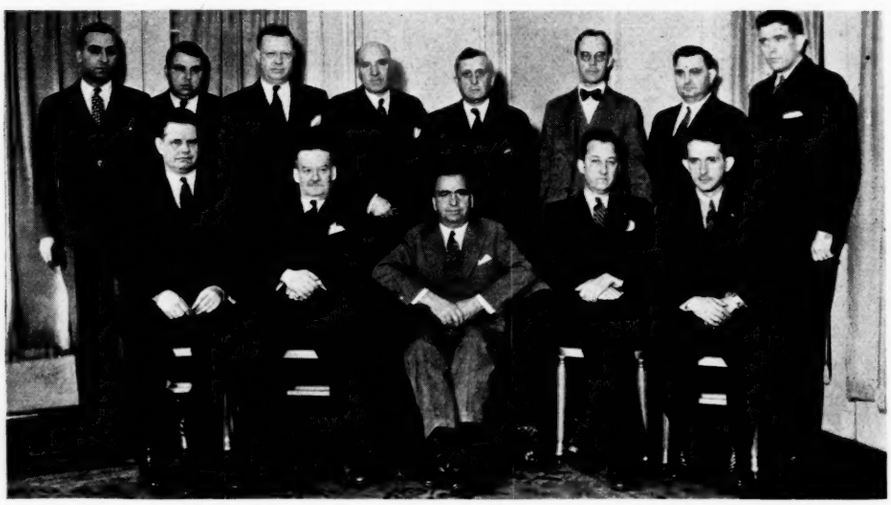
Comptroller General McCarl's decision quoted the Treasury Department as explaining that it changed specifications for the post office several times because of "great pressure" which was brought to bear on the department.

"When the Government agencies repeatedly call for supplemental bids on the same project before awarding a contract the procedure is indistinguishable from the notoriously detrimental practice known as bid peddling."

The call for bids was issued by the Treasury Department December 12, 1930, calling for granite construction to the third floor and limestone above that, with a second bid for granite construction throughout. Fourteen concerns submitted bids, the lowest for the granite-limestone construction having been submitted by the Seglin Construction Co., Inc., New York, who instigated the investigation which resulted in the decision. Supplemental bids were called for twice thereafter, ten being submitted in response to the first and seven in answer to the second.

"When it was determined that the material, etc., required by the specifications to be used in the construction of the building would result in a cost in excess of the amount believed available for the actual construction work, all of the proposals should have been rejected and the work readvertised," the comptroller general ruled.

"Especially should this have been done when it was concluded to accede to the local demand and construct the building with granite instead of with limestone from the third story. Obviously the work which it is proposed to let to the N. P. Severin Company is not the work which was offered to all bidders by advertising for competition," the decision stated.



Directors and Staff of Heating and Piping Contractors National Association

New board of directors and national staff of the Heating & Piping Contractors National Association. Reading from left to right, standing:

M. J. Chagnard, Edward G. Byrd, Justin A. Kiesling, Harry M. Hart, Walter Klie, Herbert A. Snow, John S. Jung, and S. Lewis Land.

Seated—Joseph C. Fitts, Robert D. Williams, Ray L. Spitzley, J. Lawrence DeNeille, and John H. Zink.

Gas House-Heating Customers Increase 15.5% in New England

According to the monthly summary of gas company statistics, published by the American Gas As-

sociation, the number of gas house-heating customers in the New England states increased from 6031 in March, 1930, to 6968 in March, 1931, an increase of 15.5%.

House-heating customers in the east north central states increased 7.8% from 14,798 in March, 1930, to 15,952 in March, 1931.

The number of domestic customers, including house-heating, of 158 natural gas companies, increased from 4,331,324 in March, 1930, to 4,372,838 in March, 1931, an increase of one per cent.

Heating Stokers Discussed at Midwest Bituminous Coal Conference

Comparative fuel costs, presentation of minimum setting heights for heating boilers equipped with mechanical stokers burning midwest coals, and results of stoker tests, were among the important subjects presented at the Midwest Bituminous Coal Conference, held at the University of Illinois, Urbana, Ill., May 21-22.

Prof. A. C. Willard reported on the many tests conducted at the Research Residence at Urbana. He found that the cost of gas is approximately 2.9 times that of soft coal, and 1.8 times that of anthracite. The relative costs were 82 to 100 for soft coal; 150 to 160 for anthracite, and 290 for gas, when the cost of the anthracite is $16.50 per ton; bituminous, $6.50 to $9.25 per ton, and gas, 75 cents per 1000 cu. ft., with a heating value of 565 B.t.u. per cu. ft.

L. A. Snider, consulting engineer for the state of Illinois, gave approximate requirements for coal burning plants, the data for low pressure heating plants with portable steel boilers, stoker or hand-fired, at the following average requirements in cubic feet per boiler horsepower: boiler and pump rooms, 45; coal storage, 15; total plant, 60.

For low pressure heating plants with cast iron boilers, stoker or hand-fired, the space requirements per square foot of boiler rating are: boiler room, 0.23; coal storage, 0.20; total plant space, 0.43.

E. L. Beckwith, chairman of the engineering committee of the Midwest Stoker Association, presented recommended setting heights for firebox, compact welded, and return tubular boilers when stokers are used. When formulating the tables, a heat release not to exceed 50,000 B.t.u. per cu. ft. of combustion volume per hr. was made the basic factor, this being roughly equivalent to one cubic foot of furnace volume per developed horsepower, assuming 70% efficiency. Data submitted by H. C. Carroll on coal costs on office buildings and apartment hotels with stoker installations burning Illinois screenings costing $5.15 per ton delivered, ranged from 10 cents to 19 cents per sq. ft. per season.

From the results of a series of tests, C. E. Bronson made a number of observations on the performance of stokers in firebox boilers. For the most part, efficiencies of 74.5% to 77.5% have been obtained. The maximum rate of heat release without smoke has been 50,000 B.t.u. per hr. per cu. ft. of furnace. It seems that more attention has been paid to the feeding of the coal than to the proper design of the retort for correct fuel and air distribution, which the speaker considered the important factor in maintaining good combustion conditions. Selection of the correct size of stoker for the load is essential, and for economical operation the stoker should be designed to burn screenings, so that it will be unnecessary to resort to the use of nut coal.

Prof. G. A. Young and W. T. Miller summarized tests made at Purdue University to determine the adaptability of nine grades of Indiana coals to five small stoker installations. Each of the coals was found to be reliable for continuous twelve-hour automatic operation with any one of the stokers. Combustion rates ran from a heat release of 25,000 to 36,000 B.t.u. per cu. ft. of furnace volume with four of the stokers, and 45,900 B.t.u. with an overfeed stoker, the latter corresponding to over 300% of rating. Power requirements for feeding the coal into the furnace ran from 5 to 13.5 kw.-hr. per ton.

W. J. Woodruff reviewed what had been done to remodel two of the University of Illinois heating plant boilers originally equipped with natural draft chain grates and relatively low settings. By raising the boilers to give a head-room of 14 ft., changing the baffling, and equipping the boilers with forced draft, chain grates and air preheaters, the

Courtesy U. S. Bureau of Standards

Test duct with faired entrance section for blower condition; part of the set-up for determining the characteristics of propeller fans.

fuel consumption was reduced approximately 20%. The new installation gave nearly a flat curve showing 79.4% efficiency. Under average normal operation with coal costing $2 per ton in the bunker, the fuel cost per 1,000 lb. of steam is 15 cents.

The Midwest Bituminous Coal Conference in 1932 will be held at Purdue University, Lafayette, Ind.

Government to Issue Booklet on Insulation

Announcement has been made by Secretary of Commerce Robert P. Lamont, who is chairman of the National Committee on Wood Utilization, of the appointment of a subcommittee to prepare a booklet to acquaint builders with the facts in regard to insulating a house. Preparation of this publication is one of the special projects of the committee.

The new booklet will be a cooperative project between the Government and the insulation industry and the purpose will be to inform non-technical consumers of the advantages and economies of house insulation. The publication will be prepared from an impartial viewpoint, treating practically all types of insulating materials.

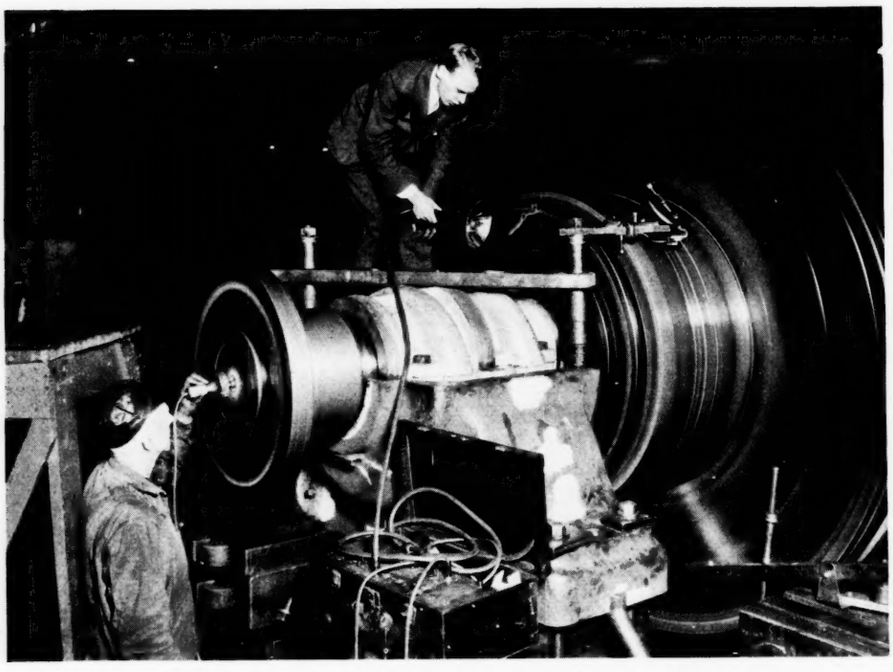
Members of the sub-committee sponsoring the project are: LeRoy E. Kern, American Institute of Architects, chairman; M. C. Betts, American Society of Agricultural Engineers; William F. Chew, National Association of Builders Exchanges; W. H. Ham, Better Homes in America; E. J. Harding, Associated General Contractors of America, Inc.; C. H. Osborne, Building Officials Conference; William S. Quniter, U. S. League of Building & Loan Associations; Leonard P. Resume, National Association of Real Estate Boards; F. B. Rowley, A.S.H.V.E.; W. A. Slater, Consulting Engineer; James S. Taylor, Bureau of Standards; S. Percy Thompson, National Retail Lumber Dealers Association.

Taylor New Secretary of Heating Board of Trade

William E. Taylor, formerly executive secretary of the Heating and Piping Contractors New York City Association, has been elected secretary of the Heating Board of Trade of New York, effective June 15, following the resignation of D. H. Sawyer. Mr. Sawyer has accepted an appointment as director of the Federal Employment Stabilization Board at Washington.

The Heating Board of Trade was formally organized January 8, 1930, following several meetings, the first, held October 8, 1929, being called by the Heating and Piping Contractors New York City Association. Following the October meeting, Mr. Taylor was elected temporary secretary of the board, a position he held in addition to his regular duties until the appointment of Mr. Sawyer the following April. In 1930 Mr. Taylor resigned his position with the contractors to become executive secretary of the advisory board and fact-finding committee of the building industries, an activity of the New York Building Congress. He has been particularly active in attempting to improve conditions in the industry. He is the author of a series of articles on the problems of the heating, piping and ventilating contractor published recently in HEATING AND VENTILATING.

The Federal Employment Stabilization Board, of which Mr. Sawyer will be director, was created by a bill passed by the last congress. The purpose of the board is to bring about, in the Federal construction agencies, the advanced planning of public work for a six-year period, and the release of such work in times of stress when the President has been satisfied that the move is warranted.



A device to make rotating objects appear to stand still

Engineers of the Westinghouse Electric & Manufacturing Company "stopping" a motor with the stroboglow. The workman on the left is holding a "mechanical oscillator" against the shaft of the motor to turn "on" the stroboglow's light, in the engineer's hand, when certain parts of the motor are in the same position.

Since the stroboglow's light is "out" while the parts are turning around to that same position, the human eye sees them only when the light is "on," retaining this image between flashes and thus making the parts appear motionless.

24% of Oil Burner Dealers Did 80% of 1930 Business

A survey of the activities of the key oil burner dealers of the country, recently completed by *Fuel Oil*, bears out the general impression that the bulk of the business is done by a limited percentage of the total number of outlets. In this field, 24% of the dealers make 80% of the total sales.

There are at present 7,800 retail sales outlets selling five or more burners per year, and 1,872 of these do the major part of the business. This information covers independent dealers, and does not take account of the operation of factory branches, which are represented principally in the very large cities.

The average number of burners

sold by these key dealers is 265 over a period of a little more than five years, and the average annual rate is 43.5 sales per dealer. The average increase in unit sales in 1930 as compared with 1929 was 6.82% in spite of the decline in residential building and other unfavorable factors.

An interesting sidelight on conditions in the trade is the relatively small turn-over in the makes handled, 66% of the dealers supplying information having handled the same burner during their entire business life. This group, incidentally, had a larger average sales record than those who changed frequently.

The average capital investment of the key dealers is $36,714, and the average sales in 1930 grossed $34,380. Sixty-four per cent of the dealers discount time payment paper at their local banks. Deferred payment selling is widely used in the oil burner field, 30.2% of 1930 sales being made on this basis. Most of the dealers handle other lines as well as oil burners, plumbing and heating and electric refrigeration being the most popular tie-ups.

An interesting item to many manufacturers is the fact that 50.86% of the burner sales involve the installation of inside basement tanks. Nearly 40% of the dealers handle both tanks and piping.

Canada Buying More Anthracite From United States

According to Eliot Farley, president of the Delaware, Lackawanna and Western Coal Company, tests favoring American anthracite have been completed by Milton Hershey Co., Ltd., of Montreal: The tests are said to refute Welsh anthracite propaganda which have affected the sale of the American product in the Dominion.

The Dominion Fuel Board, in 1928, published a bulletin which showed that Welsh anthracite was the better fuel to use. The new tests are said to show that the American coal is more efficient and economical than the Welsh product. The engineering firm's report states that, at current prices, the use of Pennsylvania anthracite results in a saving of $1.75 a ton to the householder when actual heating value is considered. Increased consumption of Pennsylvania anthracite in Canada next year is expected, Mr. Farley stated.

Committee of Ten Gets New Members

The Stoker Manufacturers Association and the American Society of Heating and Ventilating Engineers have been added to the membership of the Committee of Ten. E. B. Langenberg has been designated as the representative of the A. S. H. V. E. pending the selection of a permanent representative at the society's summer meeting. H. H. Kurtz, of the Iron Fireman Manufacturing Co., Chicago, will represent the stoker manufacturers.

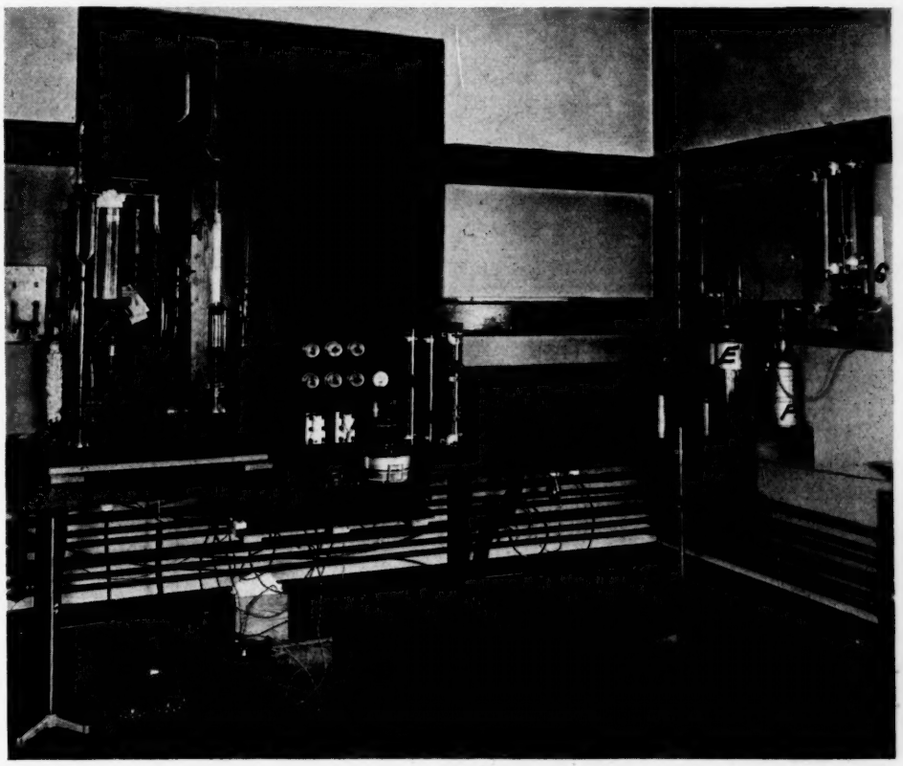
Fitts Address Anthracite Club

The Anthracite Club of Rochester, New York, which is carrying on the work of the Committee of Ten in that city, closed its spring activities with a meeting, May 25, at which the guest of honor and principal speaker was Joseph C. Fitts, secretary of the Heating and Piping Contractors National Association. The subject of his talk was Certified Heating.

The Middlesex Anthracite Club, recently organized at Malden, Mass., is confining its efforts to furthering the utilization of anthracite. Harnold C. Neal, founder of the club, was elected its first president. Jacob Ziner was elected secretary.

Gas Burners in Stack Urged to End Smoke

Through the complete combustion of bituminous coal smoke in industrial and commercial plants, what may be one of the most constructive steps taken toward the abatement and eradication of the smoke palls that envelop large cities while boiler fires are being started was announced as one of the results of the research program of the American Gas Association recently. The new use for gas as a smoke burning factor was said to offer the most practical solution of the smoke abatement problem, as well as mak-



Courtesy U. S. Bureau of Standards

The Bureau of Standards is working on the problem of maintaining constant low temperatures in the range from 0° to -170° C. The above view shows the Cryostat (E), the apparatus used for maintaining these conditions, together with accessory equipment.

ing possible greater economy in the industrial use of soft coal.

Results of experiments have proved the practicability of auxiliary gas jets which accomplish the practically complete combustion of coal dust.

Announcement was made at the meeting of the gas industry executives at the Ambassador Hotel, May 2.

Extension Course in Combustion Given in Indiana

An elementary course in combustion is being conducted at Indianapolis by the extension division of Purdue University under the direction of Prof. A. W. Cole of the department of steam engineering, for the benefit of coal dealers, salesmen and firemen.

The course includes lectures, illustrated in many instances by lantern slides, on coals, theory of combustion, boiler rooms and accessories, furnace construction, stokers, draft, furnace operation, flue gas, piping maintenance, gas, oil and pulverized coal.

The course is intended to be of value to the practical man in the boiler room and to the representatives of coal companies handling sales. Twenty men registered for the opening meeting and it is expected that the total enrollment probably will reach thirty-five.

Bradstreet's Predicts Recovery in Building Trades

A forecast by Bradstreet's says that construction will probably be one of the first major industries to recover from the depression. The prediction is based on the fact that building permits in 215 leading cities in the country showed an increase of 6.4% from March to April, against an average season decrease of 1.5%. Bradstreet's states:

"April this year showed an increase of 57.5% over January, as against an average seasonal increase of 51.6%. It will be remembered that building permits were one of the first indices of business to fall off, forecasting the present depression.

"Reports to Bradstreet's from 215 cities in the United States show a total of building permitted for in April of $151,206,846, against $142,107,807 in March this year and $179,811,014 in April a year ago. The decrease from a year ago was 15.9%, or about what it was in January of this year.

"A significant fact is that New York, with a total of $58,070,131 in April, shows an increase of 47.2% over last year and of 12.7% over the previous month. The monthly gain over a year ago has been continuous since December of last year.

"The aggregate of the 214 cities outside of New York was $93,136,715, reflecting a gain of 2.8% over March, but a decline of 33.6% from April, 1930. Complete reports on building permitted for in April reflect the improvement registered in March, although the gain in April over March is only 6.4%, while the March total showed an increase of 48.3% over February.

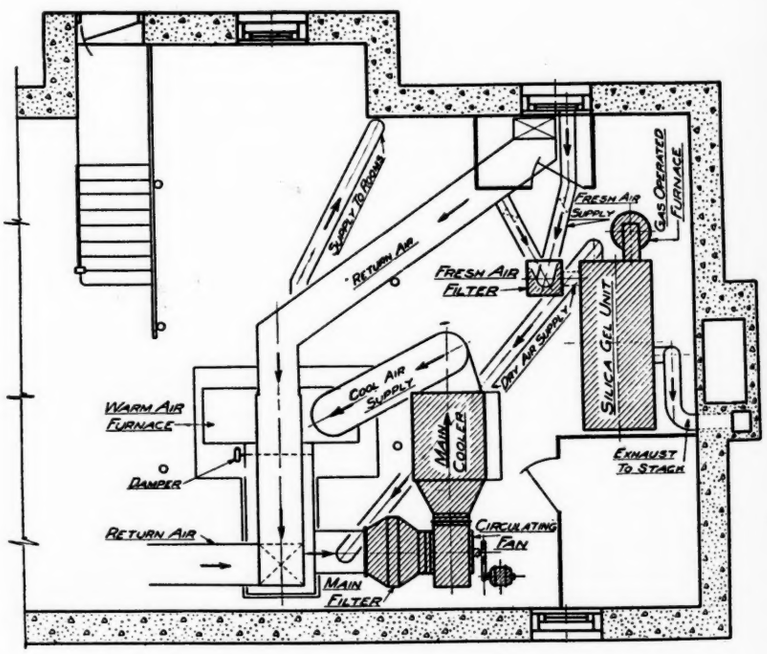
"Every section except the Central Western and Pacific and Mountain showed gains over March. The losses in these two groups were 47.1 and 43.3% respectively."

Chicago Anthracite Coal Service Organizes School

Probably the largest school yet organized for coal dealers and salesmen is now under way in Chicago under the direction of R. L. Scott, district engineer for the Anthracite Coal Service. Three classes have been organized, each starting with a membership of seventy-five. The course will cover a period of ten weeks. Lectures are given to each class one afternoon each week at the Y. M. C. A. in the Loop district.

The classes are conducted by Mr. Scott and the ten engineer members of his organization. Instruction is being given in combustion and general heating complaints and means of remedy. Following, or in connection with, the lectures each student is required to make twenty service calls of his own selection in company with one of the engineers of the Anthracite Coal Service. In this manner it is intended to give the student not only the theory of satisfactory heating service with solid fuels but also to afford practical demonstration of correction of heating troubles in practically all kinds of heating plants.

While attention is being given to anthracite primarily, the fundamentals of combustion and the correction of heating complaints are common to a considerable degree to the solid fuel family. Similar schools have been and are being conducted by the Anthracite Coal Service in principal cities of the anthracite dis-



PLAN SHOWING SOUTH END OF CELLAR AND PRESENT HEATING EQUIPMENT. SHADED AREA SHOWS SMALL ADDITIONAL SPACE FOR SUMMER AIR CONDITIONING EQUIPMENT.

Plan of cooling system as installed in a residence in Pelham, N. Y., under observation of the American Gas Association.

tribution territory with highly satisfactory results. No charge is made for the instruction, the only outlay on the part of the student being the time devoted to the course.

Worker Remains President of Stoker Manufacturers

At the annual meeting of the Stoker Manufacturers Association, held in New York, May 15, Joseph G. Worker, of the American Engineering Company, was reelected president; R. C. Goddard, of Combustioneer, Inc., was elected vice-president and F. H. Daniels of the Riley Stoker Corporation, treasurer.

F. R. Low, editor emeritus of *Power*, was elected an honorary member of the association.

Mr. Worker reported to the association that stoker sales were holding up to the 1930 level, sales of mechanical stokers in the United States for the first quarter of 1931 being exactly equal to the sales for the first quarter of 1929.

It was voted that the association should serve the public more efficiently by further development of stokers for burning coal in the home. The work of the Committee of Ten, composed of representatives of national organizations who are cooperating to collect and interchange educational data pertaining to the burning of coal in both large and household stokers, was endorsed. The purpose of this committee is to coordinate the activities of the ten organizations to promote heat satisfaction with solid fuels.

The executive committee adopted the recommended setting heights for heating boilers equipped with mechanical stokers, prepared by the Midwest Stoker Association, as a guide for architects and consulting engineers in determining the headroom requirements for heating plants.

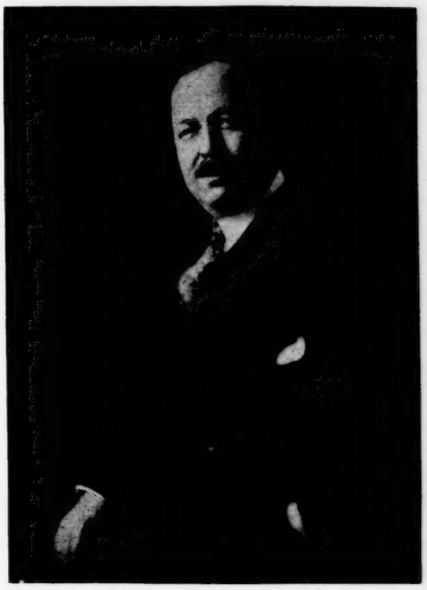
Progress in Codification of Piping Requirements for District Heating

The subcommittee on district heating of the sectional committee set up by the American Standards Association for drawing up a code for pressure piping has made its recommendations on the subject. The committee, known as Sub-Committee No. 9, has been working on the project for the past two years under the chairmanship of D. S. Boyden. The code is intended to cover items of design, manufacture, installation and test of district heating and central heating piping systems used for the distribution of steam or hot water. Items covered in the recommended code include materials, valves, fittings, bolting, provision for expansion, allowable stresses in piping, hangers, use of pipe sleeves, trapping and dripping, tests and inspections of piping and of erected lines. Copies can be secured from the American Standards Association.

Wallace M. Cosgrove

Wallace M. Cosgrove, vice-president of the American Radiator Company, died after a major operation in the Orange Memorial Hospital, June 11.

Mr. Cosgrove was born in Haverstraw, N. Y., fifty-seven years ago, and became associated with the American Radiator Company twenty-one years ago. He was a member of Bergen Lodge, F and A. M.; New York Rotary Club; Engineers' Club of New York; Carteret Club, Jersey City; a member of the board of governors of Canoe Brook Country Club; a director of Mount Tabor Field Club; a member of the Lake Valhalla Country Club, and the A. S. H. V. E.



Wallace M. Cosgrove

In 1924 Mr. Cosgrove was associated with John D. Rockefeller Jr., E. S. Harkness and others in the construction by the Bayonne Housing Corporation of model homes for workmen at Bayonne, N. J.

COMING EVENTS

June 30-July 3, 1931. Smoke Abatement Convention and Exhibit of the National Smoke Prevention Association, Grand Rapids, Mich. Headquarters at the Hotel Pantlind. Secretary, G. M. Watson, Hotel Pantlind, Grand Rapids, Mich.

July 13-17, 1931. National Association of Building Owners and Managers. Headquarters at the Olympic Hotel, Seattle, Wash.

September 7-11, 1931. Annual Convention and Mechanical Exposition of the National Association of Power Engineers. Headquarters at the Convention Hall, Kansas City, Mo. Secretary, Fred W. Raven, 417 S. Dearborn St., Chicago.

September 14-17, 1931. Sixtieth Annual Convention of the American Public Health Association, at Montreal, Canada.

October 12-13, 1931. Thirteenth Annual Convention and Exhibition of the American Gas Association, Municipal Auditorium, Atlantic City, N. J.

November 30-December 5, 1931. First National Exposition of Mechanical Handling at the Grand Central Palace, New York.

January 25-28, 1932. Joint Annual Meeting of the American Society of Heating and Ventilating Engineers, and the American Society of Refrigerating Engineers, at Cleveland, Ohio.

January 25-28, 1932. Second International Heating and Ventilating Exposition, at Cleveland, Ohio.

News of the Month

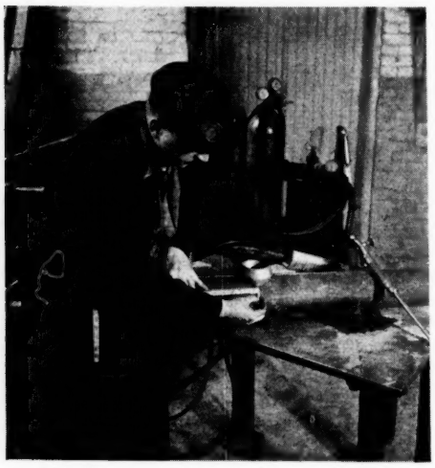
Henry & Murphy, architects, announce the removal of their offices to 247 East Exchange St., Akron, Ohio.

E. B. Langenberg announces the opening of offices at 6625 Waterman Ave., St. Louis, Mo., under the name of E. B. Engineering Company. The company will act as consultants in furnishing designs for air heating systems and preparing designs and specifications.

New Equipment

Weldolets and Thredolets

Bonney Forge and Tool Works, Allentown, Pa., has placed on the market a line of drop-forged piping fittings for welded tee junctions. The devices are outlets to which the branch pipe can be attached by

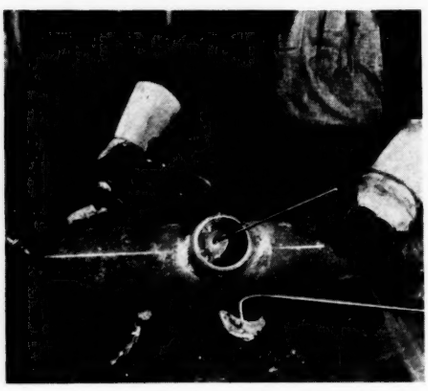


Laying out a job for which Weldolets are to be used.

screw thread, in the case of the Thredolet, or by welding, in the case of the Weldolets. The fittings are attached to the main by welding.

The fittings are welded to the main line, using a fusion or V-weld, so that they can be placed at the exact location and at the exact angle required. After the fitting is welded an S-shaped cut is made inside the outlet of the fitting. The S-shape permits removal of the "button" in two pieces.

Use of these fittings does away with the necessity of a templet, possibility of the main pipe buckling, and in most cases requires less welding material and consequently makes a neater joint. The fittings have a beveled V-edge to facilitate welding.



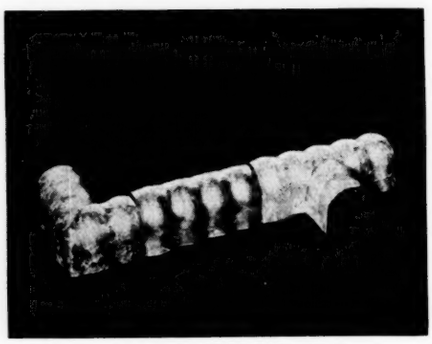
Removing the button after the Weldolet has been welded on.

Weldolets are available in sizes ranging from ½ in. to 10 in. to accommodate mains from 1 in. to 12 in. in diameter. Thredolets are available in outlet sizes from ½ in. to 6 in. for mains from 2 in. to 12 in.

Inverto Gas Conversion Unit

The Inverto gas conversion unit has been placed on the market by the Reeder Inverto Co., Inc., Stapleton, Staten Island, N. Y. The unit can be installed in less than half an hour at a low cost, and utilizes a counter draft principle of gas heat application which is said to result in a high efficiency of gas utilization.

The unit is applicable for either natural, manufactured or mixed gas; it has no moving parts; it is automatic in operation and is sold and shipped complete ready for installation with the necessary automatic controls, including room temperature finger-tip electric thermostat.



U cover for piping.

Hartmann Corrugated U Covers

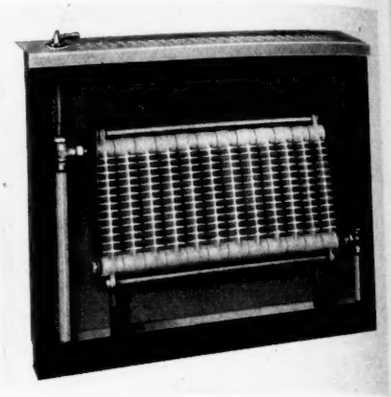
A corrugated U cover, designed for protecting underfloor piping, has been placed on the market by the Charles Hartmann Co., 975-993 Dean St., Brooklyn, N. Y. One or more corrugations overlapping at each joint holds the assembled U cover firmly in position so that the covering need not be relaid when the fill is poured.

Covers will fit all standard subfloor connections The proper combinations of tees and ells and straight lengths eliminate all cutting and fitting when installing. The covers are made from galvanized steel sheets furnished in 24 and 20 gauges.

Straight sections are available in six sizes, ranging from 6 to 36 in. in length. Elbows and tees can also be supplied.

Aero Convector

National Radiator Corp., Johnstown, Pa., announces the Aero cast



Aero cast iron convector

iron convector, designed for concealed heating. It is made up of sections in multiples of 2 in., making it available in a wide range of lengths. Sections are connected at the top and bottom with malleable push nipples. The inter-connection between the sections at the top and bottom provides positive interior circulation and air elimination, so that it can be used for hot water and one-pipe steam systems, as well as on vapor and two-pipe steam systems.

The fins are an integral part of the casting, and are widely spaced to prevent clogging from dirt. The convector will fit into recesses as shallow as 3½ in.

The units are available in depths of 3½., 4 in., 5½., in single units. The total line has a capacity range of from 0.94 to 107.2 sq. ft.

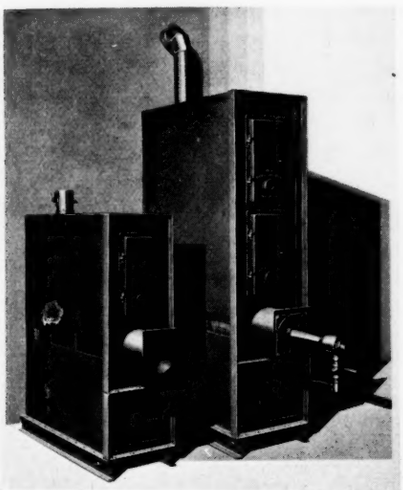
Nicholson Industrial Steam Trap

W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Pa., announces the ¾ in. style A steam trap which has just been added to the line. Applications for the trap include small unit heaters, radiators, and small steam heated processing equipment.

The built-up bellows is of large diameter made of separate discs of hard phosphor-bronze soldered to-

gether. The balanced pressure principle in bellows construction is responsible for the intermittent action and large area valve orifices used. It is attained by partially filling the bellows with a volatile liquid and creating a vacuum therein. With the vacuum inside, the atmospheric pressure compresses the bellows down against the center stop, in which position it remains when cold. Placed in the trap under compression it is therefore ready to spring into action instantly when steam arrives in the trap.

Steam, coming into contact with the bellows, causes the inside liquid under vacuum to vaporize instantly, creating a slightly greater internal than external pressure. Then, assisted by its resilience, the bellows expands quickly, closing the valve. When the cooler condensate or air collects in the trap, the internal pressure is partly dissipated and the bellows again compresses, thus opening the valve. The bellows cannot collapse as the pressure inside is always a few ounces greater than on the outside whether it be at 5 lb. or 100 lb.



Type L gas-fired heater.

Indirect Gas-Fired Heater

Drying Systems, Inc., 1800 Foster Ave., Chicago, announces the Dry-Sys Type L indirect gas-fired heater. The unit can be used in practically any arrangement for fan blast work. It can also be used either for space heating or in connection with drying operations.

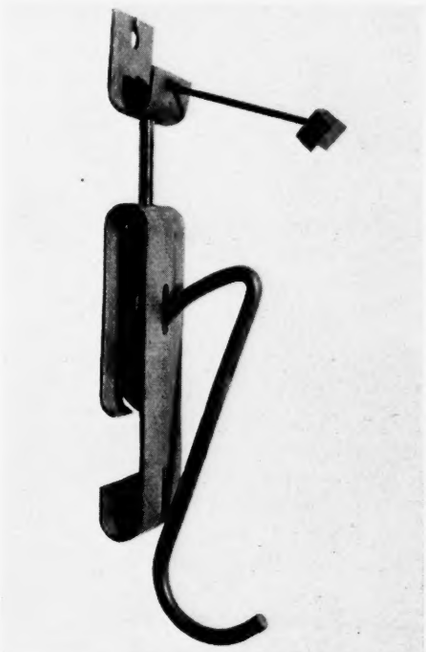
The products of combustion travel in a circuitous path inside the tubes, while the air to be heated is passed over the exterior of the tubes, the heat being transferred through a fin radiating surface.

The heater can be arranged for counter flow of gases and air so that temperatures up to 350° can be obtained; for parallel flow with a lower delivery temperature and greater air volume, or for cross flow for preheating large volumes of air.

Universal Radiator Hanger

Universal Sales Co., 154 Middlesex Road, Rochester, N. Y., has placed on the market an automatic adjusting radiator hanger, designed to replace in simple form the many parts generally used in radiator suspension, and to make installation easy.

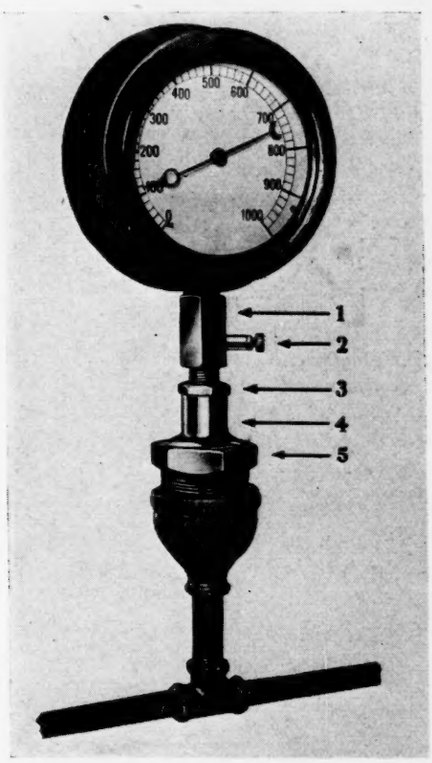
The hanger is made of machine steel with a forged hook. An extra long threaded bolt with a round slotted top takes care of different height radiators. The hook is so designed that when hanging the radiator the hook can be swung out, after which the hook will swing back into its normal position. The hanger is also available in the wall type.



Universal radiator hanger.

Sheer Electric Gas Valve

H. M. Sheer Co., Quincy, Ill., announces a new electric motor-driven gas valve for use on low pressure gas firing equipment. It is designated the Sheer type 31-A, and consists of a small induction motor used in conjunction with a relay which automatically holds the gear mechanism in an open position after the valve is moved toward the open position by the electric motor. No power is consumed by the valve when closing or when closed. The valve is furnished in ¾ in., 1 in, 1¼ in. and 1½ in. sizes.



Gauge Protecter.

Champion and Barber Gauge Protector and Non-Pulsator

Champion and Barber, Inc., 576 Subway Terminal Bldg., Los Angeles, announces two gauge protection products—the Champion gauge protector and the Champion non-pulsator.

The gauge protector is a three part, bronze bodied, rubber-bulbed pressure instrument, used to transmit line pressures to gauge recordings by means of a secondary, or bulb pressure, the recordings being the result of the compression of the secondary bulb liquid by a given line liquid. It has an anti-corrosive body, an acid resistant pressure bulb, restricts the passage of line solids into the gauge or tube movement, and makes an all-purpose gauge out of any ordinary gauge.

With the Champion non-pulsator

the control of the restriction of the fluid passage is by means of a needle valve. The pulsation recordings on the gauge are controlled entirely by the adjustment of the needle valve, regardless of the pulsations of the line pressures.

Struthers-Dunn Mid-gett Relays

The Dunco line of miniature relays, to be known as Mid-gett is being made in eight contact arrangements, by Struthers Dunn, Inc., 147 N. Juniper St., Philadelphia.

The relays are on standard bases, and measure 1⅞ in. by 2¾ in., and follow in detail the design of regular type Dunco relays, having the three-legged stool principle of construction, form-wound, moisture-proof coils, renewable contacts, accessible terminals, and with moulded bases.

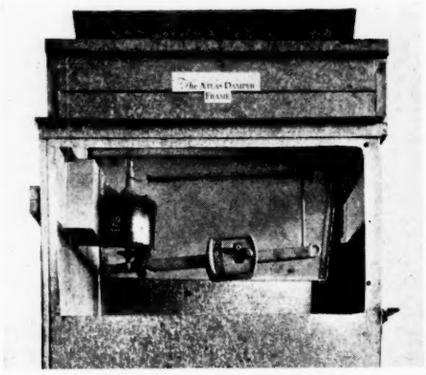
They operate on from 6 to 120 volts a. c., or 24 volts d. c., depending upon the coil used.

Clarage Type HV Fan Wheels and Assemblies

Clarage Fan Co., Kalamazoo, Mich., has developed the Type HV line of fan wheels and assemblies designed for use with stokers, oil and gas burners and warm-air furnaces. The fans are available in seven diameters in widths varying from one-third to full width. The fan wheel consists of a large number of shallow steel blades securely anchored to the back plate and inlet rim. All parts of the wheel are made from a special grade of pickled steel.

Blades are formed in dies making every blade for a certain size wheel identical in form, thickness and weight. The blades are specially curved and tipped forward in the direction of rotation, resulting in the delivery of maximum air with the minimum expenditure of power and in quiet operation.

The wheel back plate is rib stamped so that it may have maximum rigidity consistent with its weight.



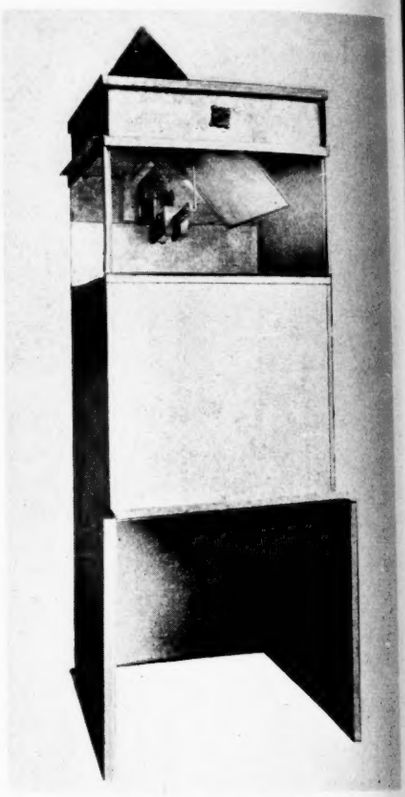
Close-up of the regulator.

Thermo-King Damper Regulator for Ventilating Ducts

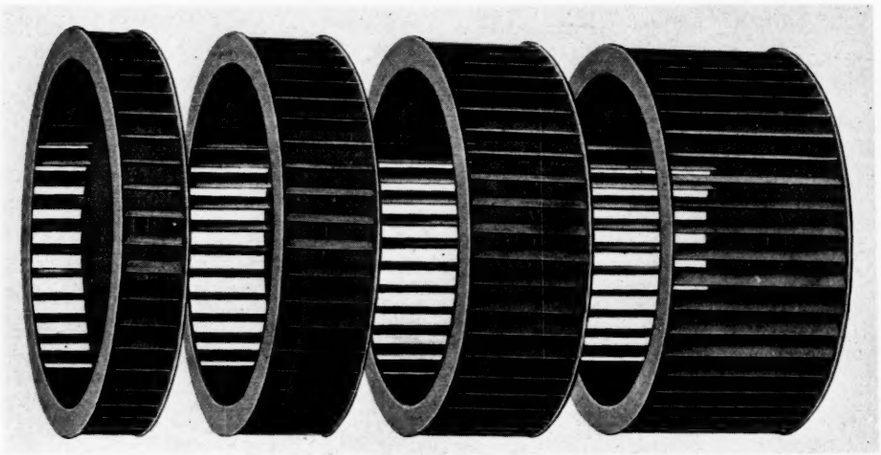
Heat Control Corp., Hazleton, Pa. and Hatfield, Mass., is manufacturing the Thermo-King damper regulator designed for use in opening and closing ventilator dampers within certain temperature ranges. The device is so arranged that the damper can be wide open, at say 70° and completely closed at 65°. The position of the damper between 65° and 70° will be in proportion to the temperature change.

The motive power is supplied by a chemical which is unusually sensitive to temperature changes. This chemical is contained in a circuit, the part of which is exposed to the air temperature being a fin-tube chamber, this being connected to the regulator. The device has a temperature range between 60° and 80°.

The damper is particularly recommended for schools and public buildings as it is not necessary to depend upon manual labor to close it after the heat in the building has been shut off. It is also a protection against down drafts. It can be used in connection with unit ventilators. The chemical does not deteriorate.



Thermo-King damper regulator

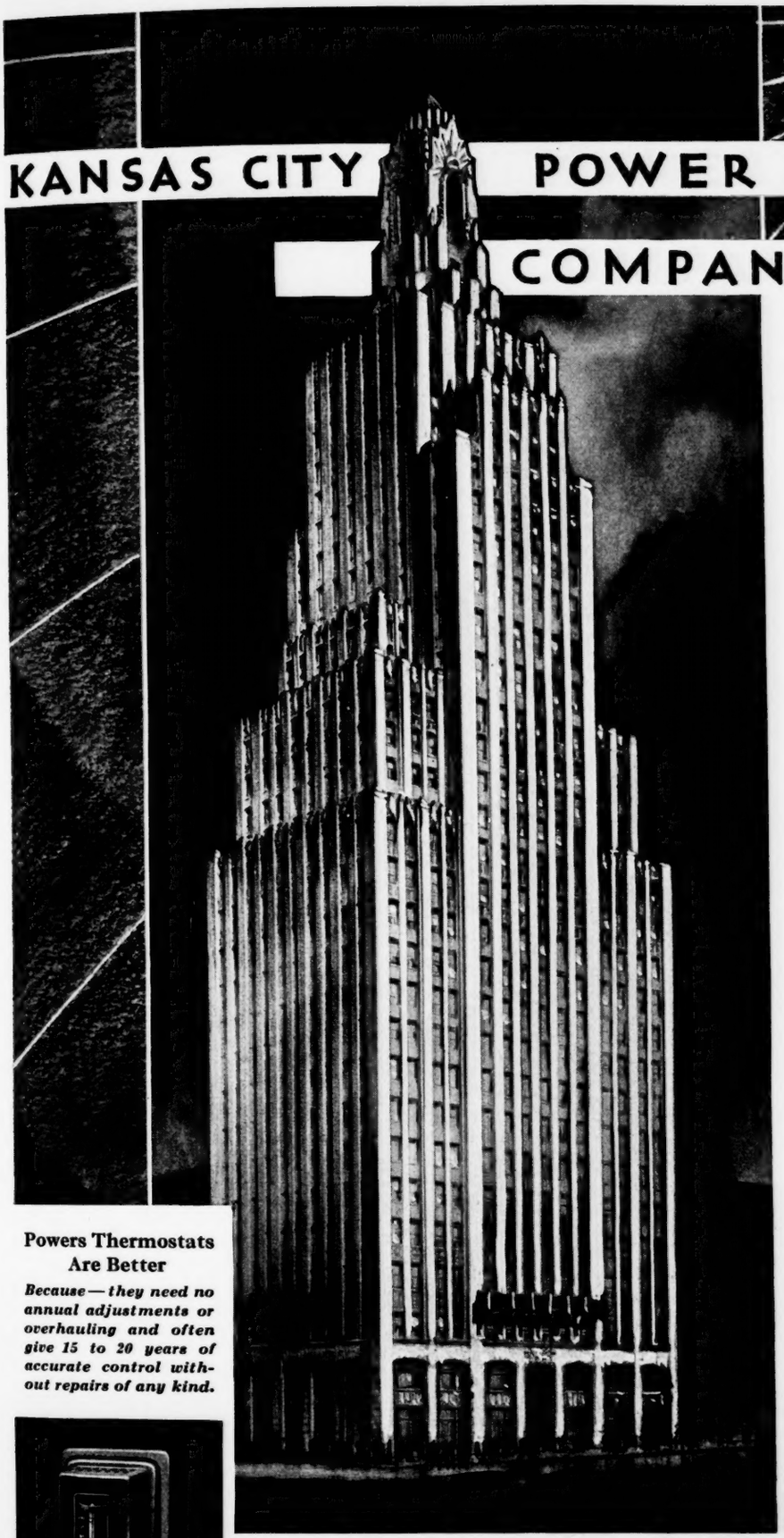


Clarage type HV fan wheels

Johnson Junior Gas Burner

The Johnson Gas Appliance Co., Cedar Rapids, Ia., recently made an interesting addition to its line of gas heating burners, in the form of the Johnson Junior burner, designed expressly to satisfy the demand for a low-priced burner. An important advantage of the unit is the fact that the burner may be purchased stripped or with any optional equipment needed. Optional equipment includes safety pilot, pressure regulator, radiant brick, and thermostatic control.

KANSAS CITY POWER AND LIGHT COMPANY BUILDING



Architects and Engineers:
HOIT, PRICE & BARNES

Heating and Plumbing Contractors:
U. S. ENGINEERING CO.
MAGILL PLBG. & HTG. CO.

In addition to the more than 350 Powers Thermostats, 700 Valves, and 16 dampers to be used in controlling the temperature of the direct and indirect radiation in this prominent 34 story building, the temperature of the shower baths will also be regulated by Powers SAFETY Shower Mixers.

Wherever QUALITY is the main consideration in the selection of mechanical equipment for any building you will invariably find Powers Control, because:

◀1▶ It often gives 15 to 20 years of Accurate and Dependable control without repairs of any kind.

◀2▶ Greater Steam Economy due to the fact that thermostats do not get out of adjustment and permit overheating.

◀3▶ Graduated Control, because of its greater accuracy, provides maximum comfort for occupants of rooms.

◀4▶ A minimum of Service Calls and the trouble and annoyance connected with them.

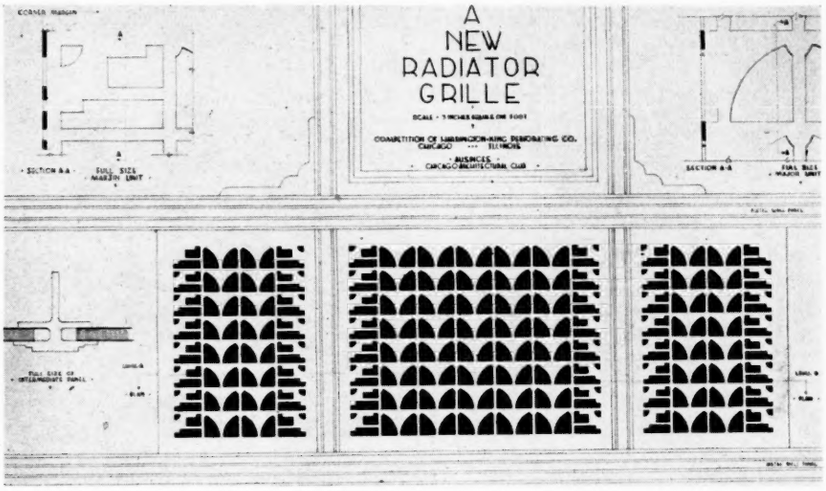
THE POWERS REGULATOR CO.
40 years of specialization in automatic heat control
2728 Greenview Ave. CHICAGO **231 E. 46th Street NEW YORK**
Offices in 41 other cities
TORONTO: 106 Lombard Street

Powers Thermostats Are Better
Because — they need no annual adjustments or overhauling and often give 15 to 20 years of accurate control without repairs of any kind.

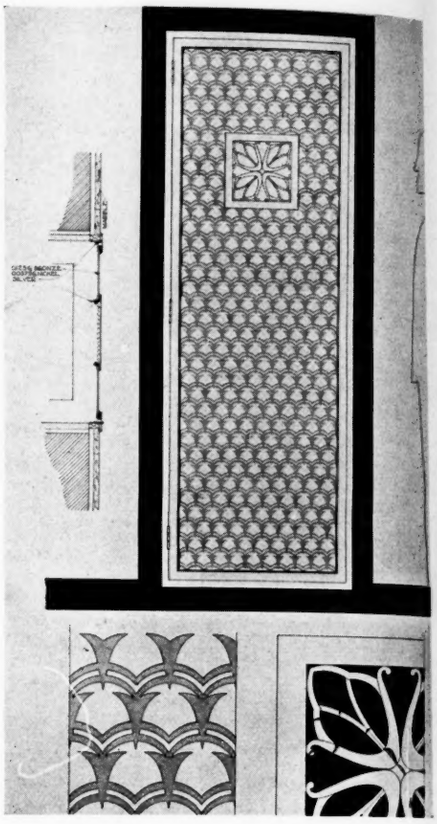
POWERS

A Competition for Design of Radiator Grille

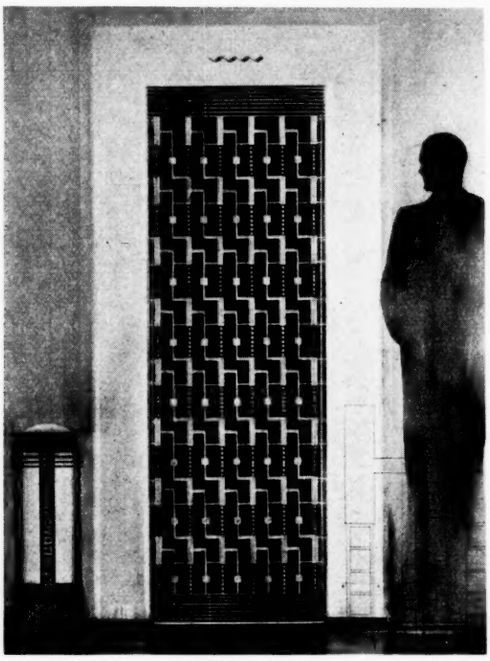
THE five designs shown below are the winners in the competition on design of a radiator grille, conducted by The Harrington & King Perforating Company, of Chicago. The manufacturer had in mind increasing the present variety in grille design to accommodate trends in modern architecture. In the opinion of the jury of awards, the competition presented a wide variation of interesting designs.



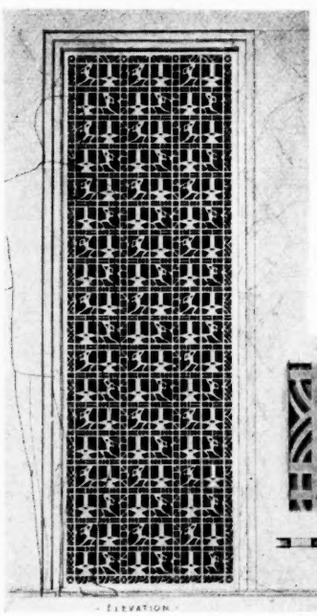
(Above) Fourth prize. G. H. Wardner, Jr., Boston, Mass. This design, while not new, has possibilities which presents itself as of combining different geometric forms.



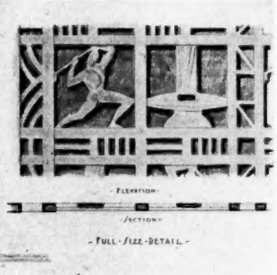
(Above) Fifth prize. Bernard Rogge, Baltimore, Md. The design of the field presents a very interesting motif which, with some modification for manufacturing, may be used in grilles of lesser importance where a horizontal movement is desired.



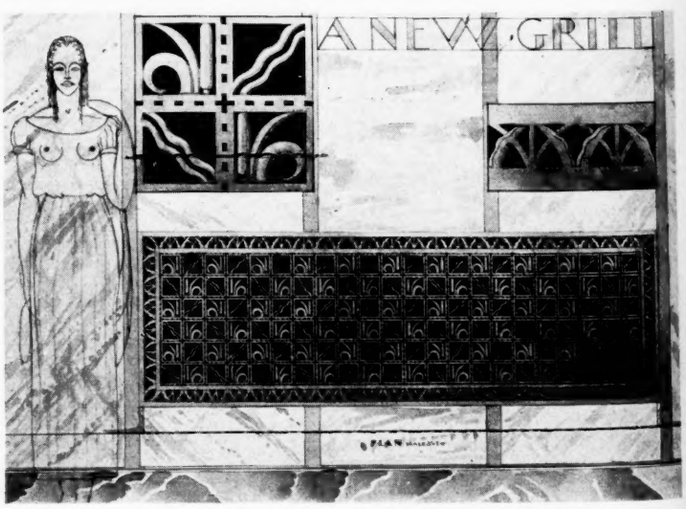
(Right) First prize. George H. Recher, Chicago. This design allows for variations and presents a thought in using different metals and construction that may be expected in grilles of special design.

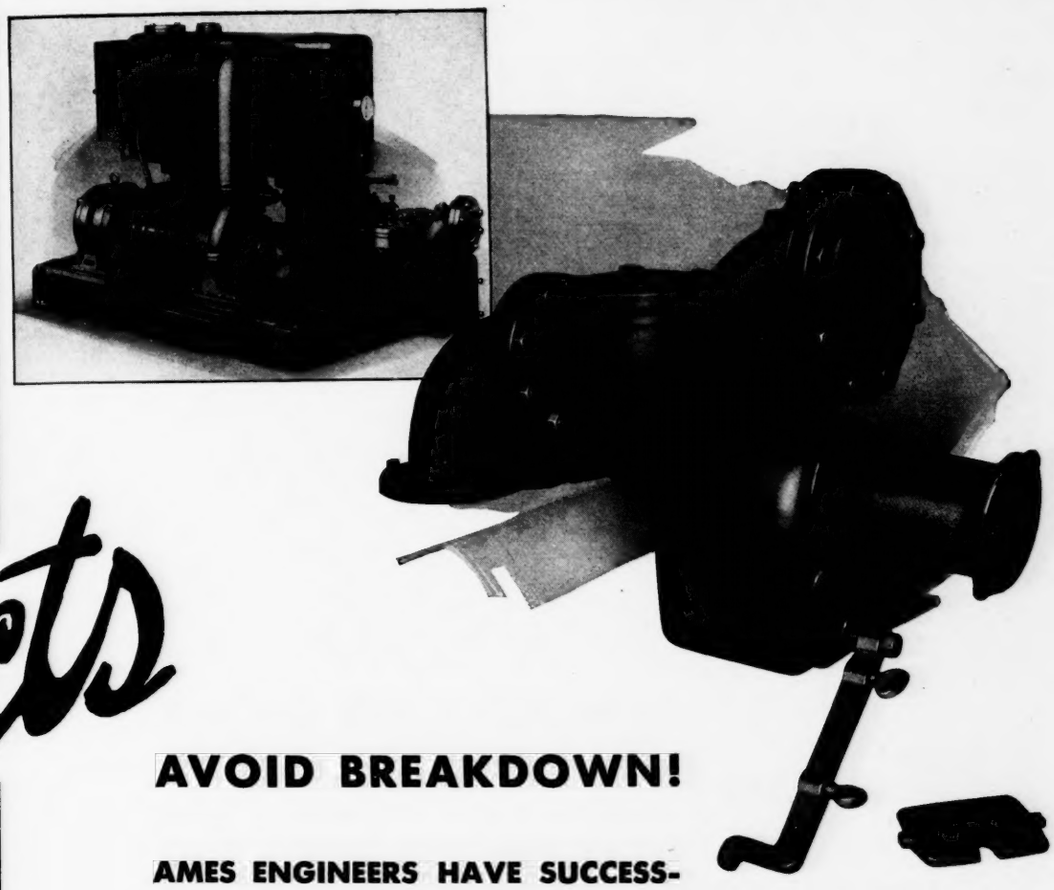


(Left) Second prize. Alexis V. Lapteff, Detroit, Mich. This presented an interesting treatment. While not important enough for end of a lobby, the idea of using figures and symbols is a good one.



(Below) Third prize. Ruth A. Dean, Boston, Mass. This was selected as presenting further ideas in getting away from symmetrical geometric design using plant motives.





Facts

AVOID BREAKDOWN!

AMES ENGINEERS HAVE SUCCESSFULLY· SOLVED THE PROBLEM OF BREAKDOWNS CAUSED BY SUCTION STRAINER BASKET BEING LEFT OUT OF SYSTEM.

THE Ames Suction Strainer Basket and Strainer Cover are constructed in one piece, and can be removed by merely loosening two setscrews.

If the strainer basket is not in place, the pump is automatically cut out of the system and sand, grit, dirt, etc., can not enter the unit to cause interruption of service and ultimate breakdown.

The Ames Suction Strainer is just another example of the many distinctive features of AMES VACUUM HEATING PUMP.

This advertisement is the Sixth of the series. Six more will follow.

Write for Bulletin No. 522 and 532

AMES PUMP COMPANY, Inc.

30 Church Street New York City

DIVISION OF

AMERICAN LOCOMOTIVE COMPANY

With the Manufacturers

Builds Air Conditioned Test Room

To facilitate the testing, calibration and setting of temperature, humidity, ventilating and air conditioning control devices, the Minneapolis-Honeywell Regulator Company is completing the construction of a room in which a dry bulb temperature of 70° and 61% relative humidity will be maintained throughout the summer as well as the winter.

The room is unusually well insulated and is being equipped at a cost of over $30,000. It measures 50 ft. x 35 ft., and has no windows. Construction is of 8 in. hollow tile, faced with 4 in. of brick with 2 in. of insulation, air spaced from the tile and tarred and plastered on the inside. The air conditioning material is contained in a pent-house on the roof.

The temperature is maintained through use of a washed air system, consisting of a washer, heating coils, fan and motor. A 500 ft. artesian well with a capacity of 450 gal. per min. cools the air and also furnishes the water supply.

The Carborundum Co., Perth Amboy, N. J., announces the opening of a factory branch oil burner department at 610 Central Ave., East Orange, N. J. C. E. Tawke will be the sales manager; M. A. Squire, branch manager; E. W. Estelle, in charge of dealer sales, and John W. Cannon in charge of manufacturing and design.

Modern Coal Burner Co., 3733 Lincoln Ave., Chicago, Ill., announces a line of manuals and books prepared for dealers covering the full subject of stoker sales, engineering, etc. The titles are: "Engineering Manual," "Sales Manual," "Installation Manual," "Service Manual" and "Stoker Encyclopedia."

American Radiator Co., New York, announces the removal of its accessories division, covering mercoid controls and allied products, to Detroit. All activities covering these products have been centered at the office of the Detroit Lubricator Co., 5842 Trumbull Ave., Detroit, Mich.

C. A. Dunham Co., 450 E. Ohio St., Chicago, Ill., has appointed Clark Keeler as manager of the San Francisco sales office, with headquarters at 232 Monadnock Bldg.

Penn Electric Switch Co., Des Moines, Ia., announces the appointment of The Worrall Company as its direct representatives in Minnesota, North and South Dakota, with headquarters at 504 Essex Bldg., Minneapolis, Minn.; the J. Sylvan Bowers Sales Co., 3805 Page Blvd., St. Louis, as exclusive distributor for its complete line of automatic controls, and the Jules W. Beneke Co., 391 Arcade Bldg., St. Louis, as its direct representative in that city.

Kieley & Mueller, Inc., 34 West 13th St., New York, recently appointed the Engineering Sales Co., 2831 South Park Way, Chicago, Ill., as its agent in northern Illinois.

National Tank Co., Inc., has removed its general offices to 7-11 Beechwood Ave., Mount Vernon, N. Y., from 480 Lexington Ave., New York.

Tube-Turns, Inc., Louisville, Ky., announces Bulletin No. 106, containing design data for expansion loops made with Tube-Turns and straight pipe. The bulletin contains a chart based on data by Crocker and McCutchan in an A. S. M. E. paper on "Frictional Resistance and Flexibility of Seamless Tube Fittings used in Pipe Welding."

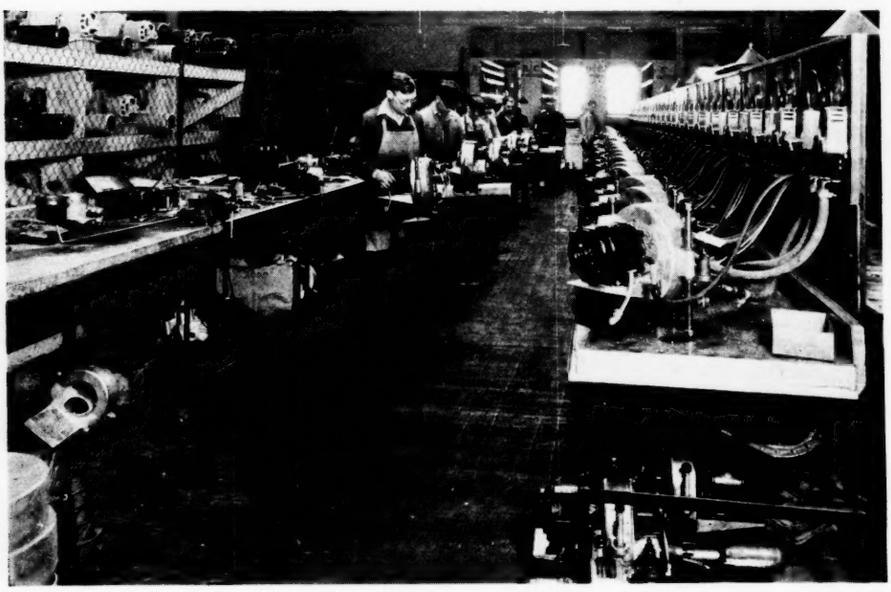
Clarage Fan Co., Kalamazoo, Mich., has appointed Charles R. McConner sales manager. Since 1928 Mr. McConner was branch manager in Detroit for the Carrier-York Corporation.

L. J. Mueller Furnace Co., Milwaukee, Wis., announces the election of H. P. Mueller as president and general manager, succeeding the late L. J. Mueller, Jr. Other officers elected are: P. E. Mueller, chairman of the board; G. C. Mueller, vice-president, and Joseph Schlueter, secretary and treasurer.

The Brown Instrument Co., Philadelphia, Pa., announces the appointment of R. D. Bean, formerly manager of the engineering development department, as chief engineer.

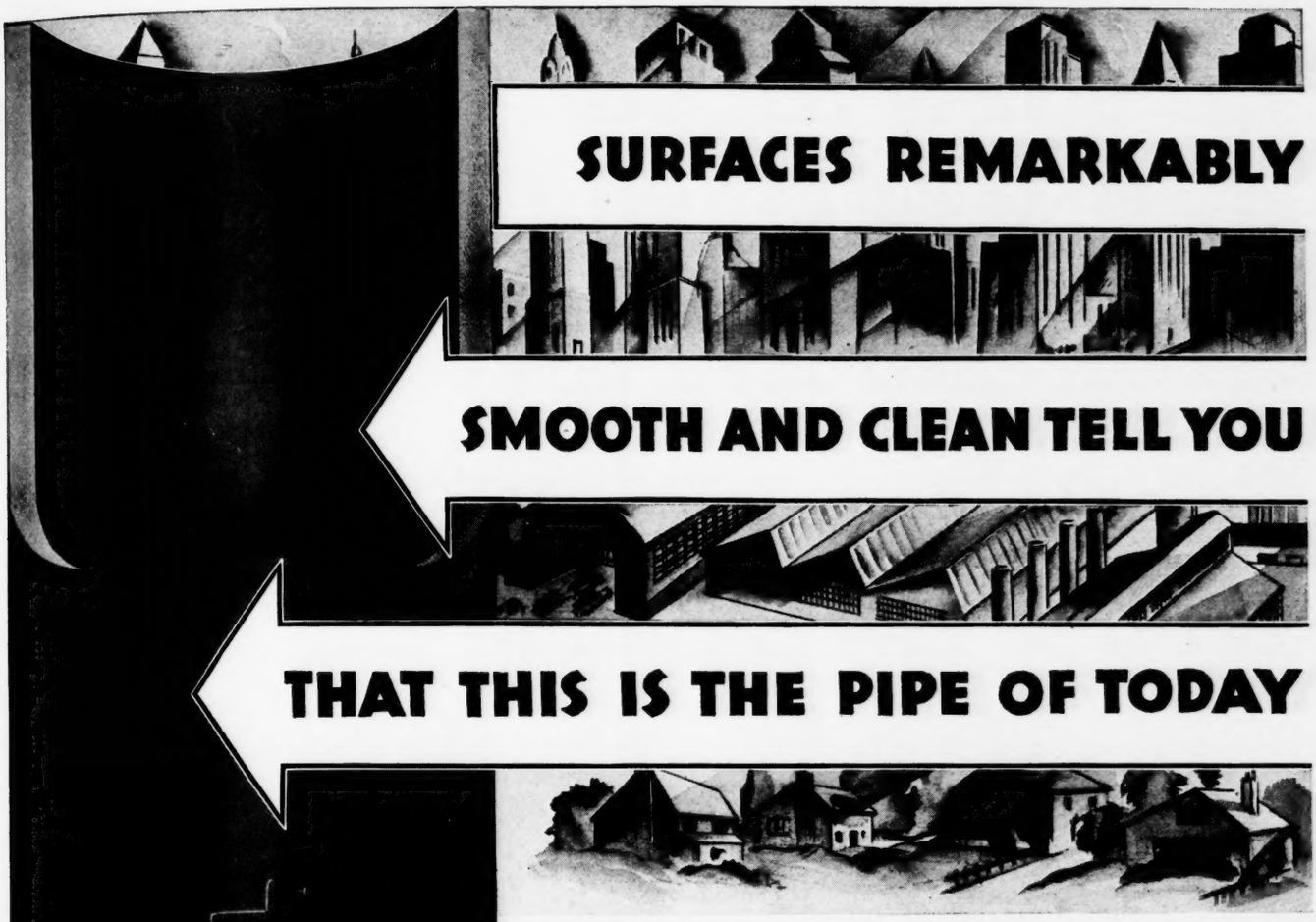
The Peerless Heater Co., Boyertown, Pa., recently appointed the Himmelblau, Agazim Co., 30 N. Dearborn St., Chicago, Ill., as its new sales and service representative in northern Illinois and eastern Indiana.

Armstrong Cork Co., Lancaster, Pa., has consolidated all the Boston branch sales offices and warehouses in one office at 286 Congress Street. In addition, the Temlok Dealer Sales Division of the Armstrong Cork & Insulation Company, recently organized for the sale of Armstrong's Temlok Insulation, will be located at the new address.



Testing 81 oil burners a day

The Century Engineering Corp., Cedar Rapids, Iowa, is using a complete testing rack for oil burners, the result of several years of experimental work. The rack provides a test which reproduces actual operating conditions of an oil burner in the basement of the user. Twenty-seven burners can be tested at one time. It is operated in three eight-hour shifts, giving a capacity of 81 units per day.



SURFACES REMARKABLY SMOOTH AND CLEAN TELL YOU THAT THIS IS THE PIPE OF TODAY

NATIONAL

FOR the skyscraper—for the factory—for the home ... this clean, smooth pipe fills, in every way, the demands of modern service. Free from troublesome mill-scale (one of the principal causes of "pitting") NATIONAL Scale Free Pipe means that corrosion is reduced, annoyances due to loose scale are eliminated and a higher order of service is assured. For galvanizing and other protective coatings this exceptionally smooth base is ideal. All in all, longer life with greater economy is the net practical result. Whether you buy, specify or install pipe for skyscraper, factory or home, be sure to insist on the pipe of today—NATIONAL Scale Free—

America's Standard Wrought Pipe

NATIONAL TUBE COMPANY ◆ Pittsburgh, Pa.
Subsidiary of United States Steel Corporation

NATIONAL

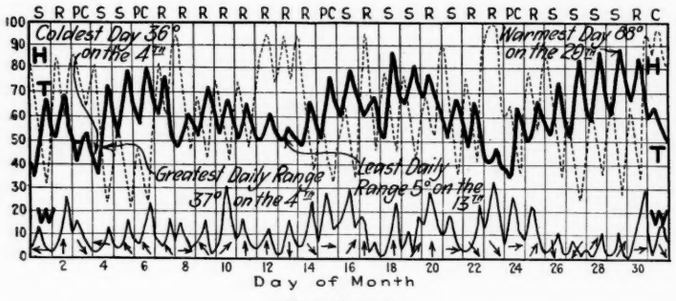
US STEEL

SCALE FREE PIPE

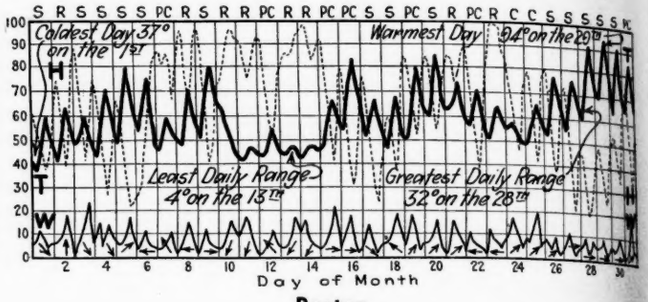
SPELLERIZED

The Weather

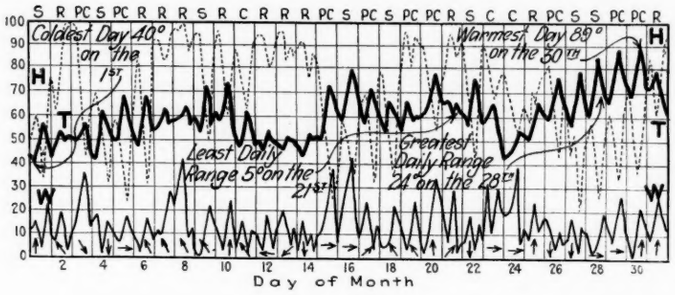
May, 1931


Coldest Day 36° on the 4TH
Warmest Day 88° on the 20TH
Greatest Daily Range 37° on the 4TH
Least Daily Range 5° on the 13TH
Day of Month

Pittsburgh

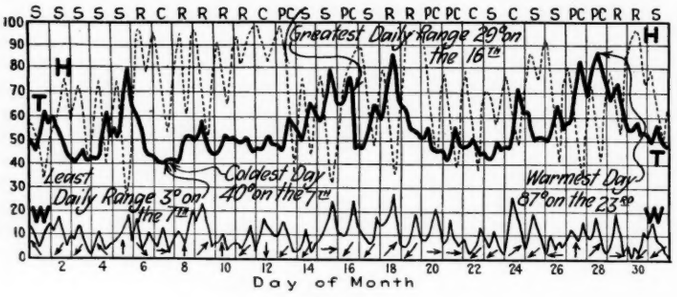

Coldest Day 37° on the 1ST
Warmest Day 94° on the 20TH
Least Daily Range 4° on the 13TH
Greatest Daily Range 32° on the 28TH
Day of Month

Boston

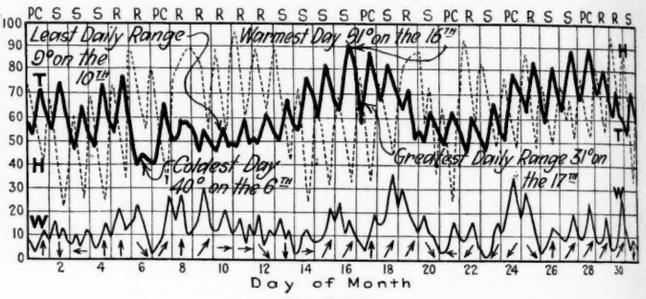

Coldest Day 40° on the 1ST
Warmest Day 89° on the 30TH
Least Daily Range 5° on the 21ST
Greatest Daily Range 24° on the 28TH
Day of Month

New York

(Hourly Observation of the Relative Humidity Plotted on this Chart.)


Greatest Daily Range 29° on the 16TH
Least Daily Range 3° on the 7TH
Coldest Day 40° on the 7TH
Warmest Day 87° on the 23RD
Day of Month

Chicago


Least Daily Range 9° on the 10TH
Warmest Day 91° on the 18TH
Coldest Day 40° on the 6TH
Greatest Daily Range 31° on the 17TH
Day of Month

St. Louis

	New York	Boston	Pittsburgh	Chicago	St. Louis
Highest temperature, deg. F.	89	94	88	87	91
Date of highest temperature	30	29	29	28	16
Lowest temperature, deg. F.	40	37	36	40	40
Date of lowest temperature	1	1	4	7	6
Greatest daily range, deg. F.	24	32	37	29	31
Date of greatest daily range	28	28	4	16	17
Least daily range, deg. F.	5	4	5	3	9
Date of least daily range	21	13	13	7	10
Mean temperature for month, deg. F.	60.4	60.3	60.8	55.6	62.8
Normal mean temperature for month, deg. F.	60.6	57.1	62.3	57.5	67.0
Total precipitation, this month, inches	3.93	4.51	5.46	5.08	3.61
Total snowfall, this month, inches	0	0	0	0	0
Normal precipitation, this month, inches	3.24	3.18	3.21	3.54	4.34
Total wind movement, this month, miles	9,116	5,238	6421	6654	8235
Average hourly wind velocity, miles	12.3	7.0	8.6	8.9	11.1
Prevailing direction of wind	S	S.W.	S.W.	N.E.	S.W.
Number of clear days	8	9	6	12	13
Number of partly cloudy days	12	12	13	7	11
Number of cloudy days	11	10	12	12	7
Number of days with precipitation	13	10	19	9	12
Number of days with snowfall	None	None	None	None	None
Snow on ground, at end of month	None	None	None	None	None

Plotted from records especially compiled for HEATING AND VENTILATING by the United States Weather Bureau.
Heavy lines indicate temperatures in degrees F. Light lines indicate wind in miles per hour.
Broken lines indicate humidity in percentage from readings at 8 a. m., 12 m., and 8 p. m. Arrows fly with prevailing directions of wind.
S—clear, PC—partly cloudy, C—cloudy, R—rain, Sn—snow.

Cool Running DEPENDABLE

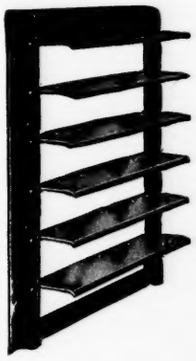
BIG husky motors, fully enclosed, provide large air removal capacity, complete protection from dirt and fumes—and yet their temperature rise is less than 40° C.

Wool-packed bearings and generous oil wells assure a minimum of a full year's normal operation without re-lubrication.

Emerson's 40 years' experience in fan and motor design guarantees unusually efficient exhaust fan service.

12 to 36-inch sizes
AC and DC Types

All steel welded construction and individually balanced blades add long life and quiet operation by reducing vibration. Automatic aluminum leaf shutters are available for all sizes.



Write for Bulletin 3519-A

The Emerson Electric Mfg. Co.
2018 Washington Ave., Saint Louis
806 W. Washington Blvd., Chicago
155 Sixth Avenue, New York City

EMERSON
EXHAUST
FANS

Degree Days and Unit Fuel Consumption in Typical Cities

May, 1931

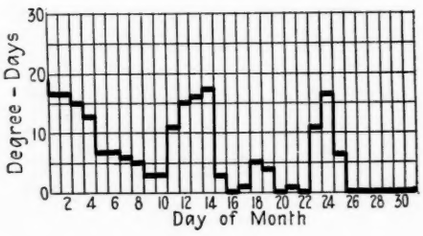
UNIT fuel consumption figures given below must be corrected for efficiency, heat content of fuel other than that listed below, for radiation emitting other than 240 B.t.u. per hr., and for radiation calculated on a basis of other than zero outside to 70° inside.

Coal is assumed as having a heat content of 12,000 B.t.u. per lb., gas, 1000 B.t.u. per cu. ft. and oil 140,000 B.t.u. per gal. To correct for other heating values, multiply the fuel consumption listed under the charts by the standard heat content just listed, and divide by the heat content of the fuel actually being used in the installation being calculated.

For radiation installed for any other outside temperatures than zero, multiply the fuel consumption given under the charts by 70°, divided by the quantity (70 minus the outside temperature used).

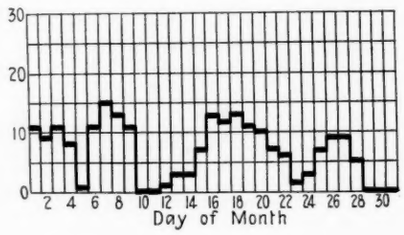
To correct for efficiency, divide the fuel consumption by the efficiency of the heating installation.

For water radiation, multiply the fuel consumption which is given for steam radiation by 5/8.



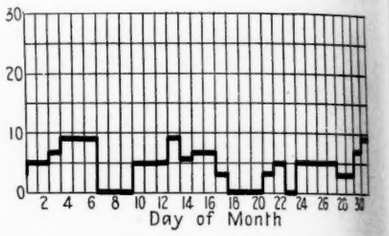
New York

Degree Days 201—to Date, 5078
Lb. of Coal per Sq. Ft. of Radiation for this Month, 1.61.
Gal. of Oil per Sq. Ft. of Radiation for this Month, 0.138.
Cu. Ft. of Gas per Sq. Ft. of Radiation for this Month, 19.30.
(See Footnote)



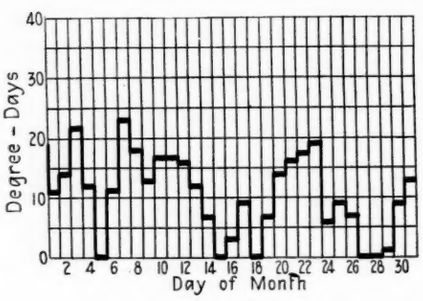
Seattle

Degree Days 211—to Date, 4200
Lb. of Coal per Sq. Ft. of Radiation for this Month, 1.69.
Gal. of Oil per Sq. Ft. of Radiation for this Month, 0.145.
Cu. Ft. of Gas per Sq. Ft. of Radiation for this Month, 20.26.
(See Footnote)



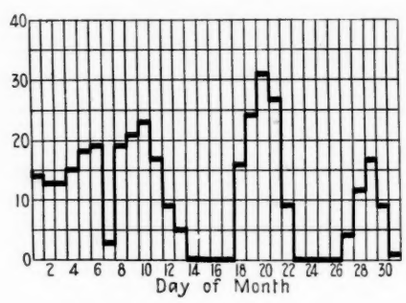
San Francisco

Degree Days 141—to Date, 1937
Lb. of Coal per Sq. Ft. of Radiation for this Month, 1.13.
Gal. of Oil per Sq. Ft. of Radiation for this Month, 0.097.
Cu. Ft. of Gas per Sq. Ft. of Radiation for this Month, 13.54.
(See Footnote)



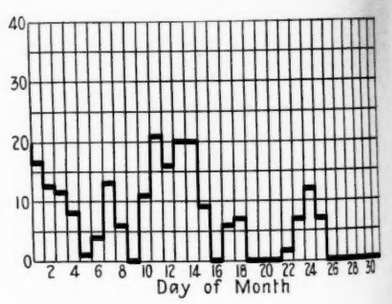
Chicago

Degree Days 323—to Date, 5859
Lb. of Coal per Sq. Ft. of Radiation for this Month, 2.58.
Gal. of Oil per Sq. Ft. of Radiation for this Month, 0.221.
Cu. Ft. of Gas per Sq. Ft. of Radiation for this Month, 31.01.
(See Footnote)



Denver

Degree Days 339—to Date, 5689
Lb. of Coal per Sq. Ft. of Radiation for this Month, 2.71.
Gal. of Oil per Sq. Ft. of Radiation for this Month, 0.232.
Cu. Ft. of Gas per Sq. Ft. of Radiation for this Month, 32.54.
(See Footnote)

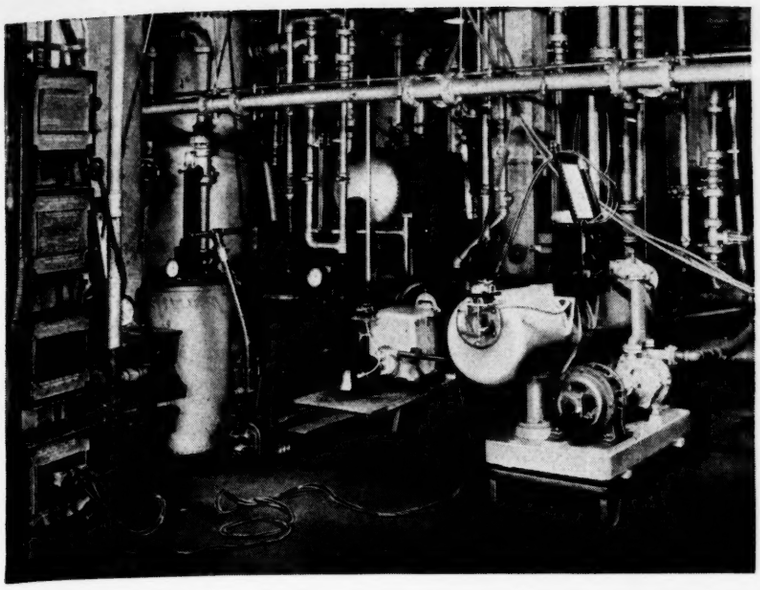


Boston

Degree Days 212—To date, 5467
Lb. of Coal per Sq. Ft. of Radiation for this Month, 1.70.
Gal. of Oil per Sq. Ft. of Radiation for this Month, 0.145.
Cu. Ft. of Gas per Sq. Ft. of Radiation for this Month, 20.35.
(See Footnote)

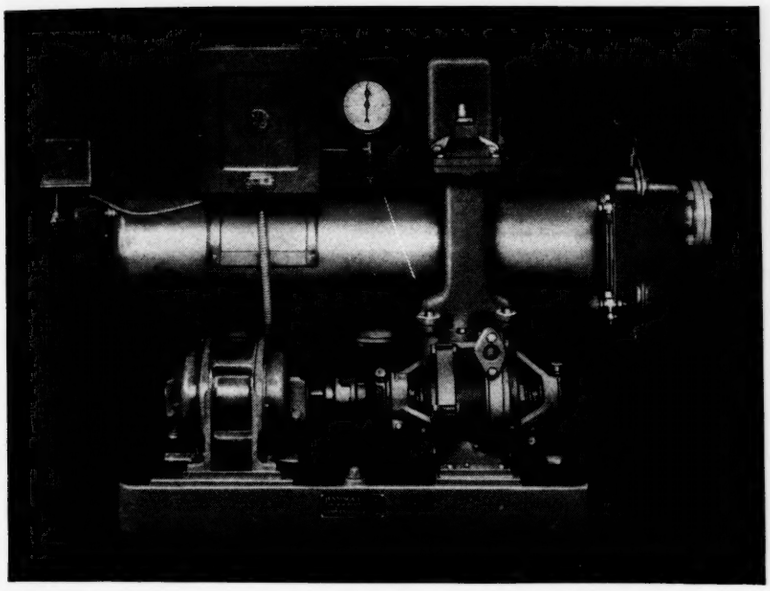
Fuel consumption figures must be corrected for local conditions as explained above.

(Continued on Page 118)



Corner of laboratory in Nash factory where Jennings Pumps are tested.

Liberal Capacity at Minimum Horsepower *assures low operating costs*



Jennings Vacuum Heating Pumps are furnished in capacities of 4 to 400 g.p.m. of water and 3 to 171 cu. ft. per min. of air. For serving up to 300,000 sq. ft. equivalent direct radiation.

ECONOMICAL operation is assured by the unusual design of the Jennings Vacuum Heating Pump.

The Jennings consists of two independent pumping units. One pumps only water, the other only air. Each unit can be, and is, designed for maximum efficiency. Less horsepower is required to drive the pump because neither of these units is ever overloaded by having to handle air and water together. The generous capacity provided permits the pump to clear the heating system rapidly, so that a Jennings operates only for short periods at a time.

The air and water capacities of every Jennings Heating Pump are determined for you by test at the factory. Power consumed is also checked. These tests, conducted under the same conditions of vacuum and pressure as are to prevail in actual service, are your guarantee of good heating pump performance.

NASH ENGINEERING COMPANY
81 WILSON RD. SO. NORWALK, CONN.

Jennings Pumps

VACUUM PUMPS AND COMPRESSORS FOR AIR AND GAS • • RETURN LINE AND AIR LINE VACUUM STEAM HEATING PUMPS • • CONDENSATION PUMPS • • CENTRIFUGAL PUMPS • • SUCTION (SELF-PRIMING) CENTRIFUGAL PUMPS • • SUCTION SUMP PUMPS • • SEWAGE PUMPS • • PNEUMATIC SEWAGE EJECTORS

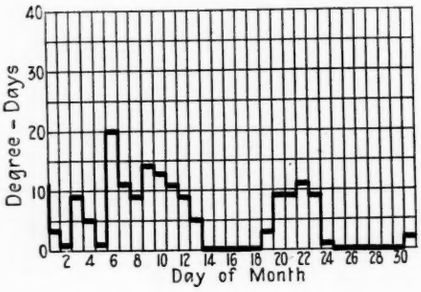
NASH ENGINEERING COMPANY
81 Wilson Road, South Norwalk, Conn.
Gentlemen:
Please send me Bulletins 85 and 87 describing Jennings Vacuum Heating Pumps.

*Name*_____ *Title*_____
*Address*_____
*City*_____ *State*_____

Degree Days and Unit Fuel Consumption in Typical Cities

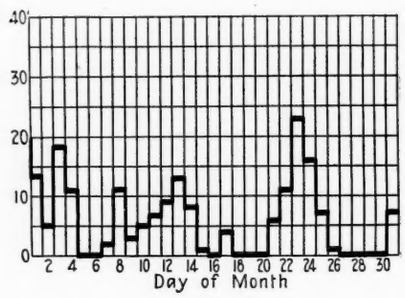
May, 1931

(Continued from Page 116)



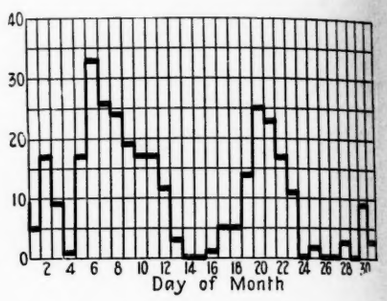
St. Louis

Degree Days 155—to Date, 4412
Lb. of Coal per Sq. Ft. of Radiation for this Month, 1.24.
Gal. of Oil per Sq. Ft. of Radiation for this Month, 0.106.
Cu. Ft. of Gas per Sq. Ft. of Radiation for this Month, 14.88.
(See Footnote, Page 116)



Pittsburgh

Degree Days 181—to Date, 5447
Lb. of Coal per Sq. Ft. of Radiation for this Month, 1.45.
Gal. of Oil per Sq. Ft. of Radiation for this Month, 0.124.
Cu. Ft. of Gas per Sq. Ft. of Radiation for this Month, 17.38.
(See Footnote, Page 116)



Minneapolis

Degree Days 308—to Date 6782
Lb. of Coal per Sq. Ft. of Radiation for this Month, 2.46.
Gal. of Oil per Sq. Ft. of Radiation for this Month, 0.211.
Cu. Ft. of Gas per Sq. Ft. of Radiation for this Month, 29.57.
(See Footnote, Page 116)

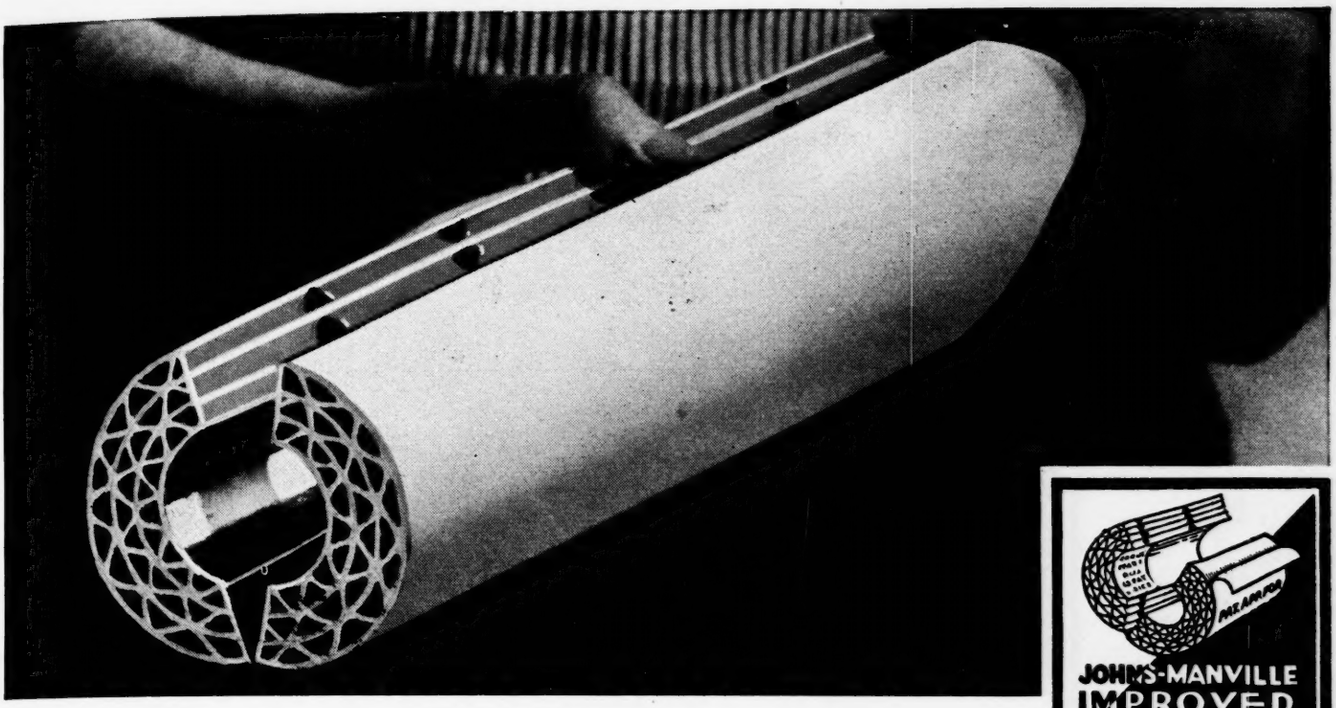
	Los Angeles	Baltimore	Philadelphia	New Orleans	Atlanta	Cleveland	Cincinnati	Detroit
Degree Days	5	96	117	0	68	265	200	241
Degree Days to Date	663	4348	4521	1435	3428	5785	5046	6329
Lb. of Coal per Sq. Ft. of Radiation for May, 1931	0.04	0.77	0.93	—	0.54	2.12	1.60	1.93
Gal. of Oil per Sq. Ft. of Radiation for May, 1931	0.003	0.066	0.080	—	0.047	0.182	0.137	0.165
Cu. Ft. of Gas per Sq. Ft. of Radiation for May, 1931	0.48	9.22	11.23	—	6.528	25.44	19.20	23.14

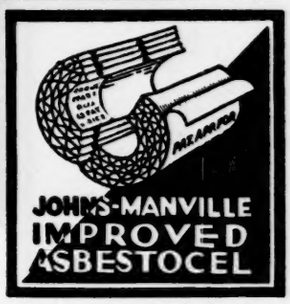
(See Footnote, Page 116)

	Buffalo	Birmingham	Indianapolis	Memphis	Des Moines	Kansas City	Louisville	Galveston
Degree Days	308	41	226	73	245	178	172	2
Degree Days to Date	6486	2921	5330	3267	5661	4562	4583	1402
Lb. of Coal per Sq. Ft. of Radiation for May, 1931	2.46	0.33	1.81	0.58	1.96	1.42	1.38	0.02
Gal. of Oil per Sq. Ft. of Radiation for May, 1931	0.211	0.028	0.155	0.050	0.168	0.122	0.118	0.001
Cu. Ft. of Gas per Sq. Ft. of Radiation for May, 1931	29.57	3.94	21.70	7.01	23.52	17.09	16.51	0.19

(See Footnote, Page 116)

Use Improved Asbestocel





This red and white label on every section of Improved Asbestocel identifies it to your customers.

for a faster, better job ...more profits for you

EASY to handle—easy to apply—easy to sell, Johns-Manville Improved Asbestocel offers special advantages to you as a heating expert.

Every section of Improved Asbestocel is designed to save money for you and your customer. Strong and substantial, Improved Asbestocel stands up under rapid handling—even a 10-foot drop from a ladder will not damage it.

Every section of Improved Asbestocel is uniform in length and thickness. It is round and stays round. It is straight lined and clean cut. Snap it shut around the pipe and it fits firm and snug without waste motion and without squeezing into place. Improved Asbestocel always makes a smooth neat job of which you can be proud—that will bring you future business—that will deliver more heat per ton of coal.

Improved Asbestocel is the only domestic heating pipe insulation that is nationally advertised. For many years, your customers have been taught to realize that the red band of Improved Asbestocel identifies a superior product, capable of giving greater efficiency and better appearance on home-heating systems.

Try Improved Asbestocel on your next job. Let it speak for itself. There is a Johns-Manville distributor near you—a telephone call will bring prompt service. Get in touch with him or write us direct for his address. Address Johns-Manville, 292 Madison Ave., New York City.

and don't forget the boiler . . .

While you are applying Improved Asbestocel Pipe Covering, put on a boiler covering also that will be in keeping with the quality of the job. We recommend Improved Asbestocel Sheets and Blocks with a finish coat of J-M No. 302 or No. 352 Cement which drys to a smooth white finish. We will gladly work with you in estimating the cost of the job.

Johns-Manville

JOHNS-MANVILLE JM PRODUCTS

Low Pressure Insulation